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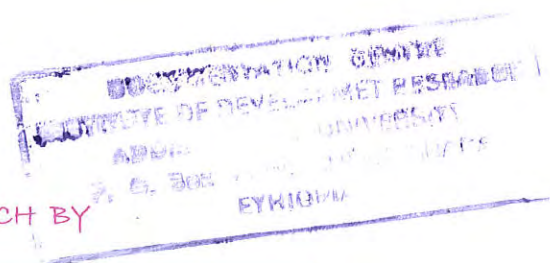
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**LAND USE DYNAMICS AND ITS
IMPLICATION ON LIVELIHOODS
THE CASE OF TWO NEIGHBORING WOREDAS IN
TIGRAI REGIONAL STATE**



A RESEARCH BY

TEKLEWEINY GHEBREMEDHIN

**JULY 2009
ADDIS ABABA**

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Title

*Land use Dynamics and Its Implication on
Livelihoods. The case of Two Neighboring Woredas in
Tigray Regional State*

By
Tekleweiny Ghebremedhin

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In Loving Memory of

W/ro TEKe'A BEYENE LEMA

My dearest mother who have gone a lot for me through her entire life; whose strength and endurance gave me the courage to shape my personality. I will never forget how you worked hard day and night to raise me and give me the best you possibly could. I know what my success means to you. You were, you are and you will always have a very special place inside my heart for you stood by my side especially in times when my life seemed to fall apart. Did I ever tell you that you are the best friend I ever have?! May the almighty God along with His mother, St. Marry of Zion in Axum, give you long and peaceful life for you are incredibly sweet !!

TABLE OF CONTENTS

	<i>Page</i>
<i>List of tables</i>	
<i>List of figures</i>	
<i>List of maps</i>	
<i>List of appendices</i>	
<i>Acronyms</i>	
<i>Acknowledgement</i>	
<i>Abstract</i>	
1. Introduction	1
1.1 Background Information	1
1.2 General Characteristics of the Study Area	4
1.2.1 The physical environment	4
1.3 Statement of the problem	7
1.4 General Objective	8
1.4.1 Specific Objective	8
1.4.2 Statement of the Problem	8
1.5 Significance of the Study	8
1.6 Scope and limitation of the Study	9
1.7 Organization of the Study	10
2. The Linkage between Land-use Change and Livelihood	11
2.1 Land-Use/Land-Cover Changes	15
2.2 Causes of Land-Use/Land-Cover Changes	16
2.3 Soil Erosion as a result of Land-use Change	18
2.4 Agriculture and Land Use	20
2.5 Land-Use and Livelihood	22
2.6 Conceptual Framework	24
2.7 Socioeconomic and institutional factors	25
2.8 Population pressure	26
2.9 Poverty	27
2.10 Land tenure	28

3. Research Methods and Materials	34
3.1 Research Approach and Design.....	34
3.2 Research Sampling	34
3.2.1 Sampling Area	34
3.2.2 Sample Households	35
3.3 Data Needed	36
3.4 Data Sources.....	36
3.5 Data Collection Technique	38
3.6 Data Collection Tools.....	38
3.7 Data Processing and Analysis	38
4. Data Analysis and Discussion	39
<i>Part One</i>	
4.1 The Human Environment	39
4.2 Institutions.....	47
4.3 Demographic Dynamics and Changes in Livelihood Assets.....	48
4.3.1 Demographic dynamics.....	48
4.3.2 Changes in livelihood assets.....	51
4.4 Correlates of Sustainable Rural Livelihoods.....	58
i. Livelihood sustainability matrix.....	58
ii. The Bi-variant analysis	59
a) Demographic Dynamics and Sustainable Livelihoods	60
b) Changes in livelihood assets	61
<i>Part Two</i>	
4.5 Land -use/cover Dynamics Analysis	64
4.5.1 Change in land-use/cover	64
a) Change in forest land	66
b) Change in moderately-disturbed forest land	67
c) Change in bush land	69
d) Change in degraded land	71
e) Change in cultivated and settlement land	70
4.5.2 Causes of land-use/cover change	73

4.6 Soil Erosion.....	75
4.6.1 Magnitude and rate of soil loss by riling	75
4.6.2 Processes and immediate causes of rill initiation and dev't	77
4.7 Vulnerability Context.....	80
4.7.1 Trends, shocks and seasonability.....	80
4.7.2 Coping strategies.....	85
4.8 Livelihood Strategies	86
i. Extensification.....	86
ii. Intensification	87
iii. Diversification	89
4.9 Land Management Activities with Conventional Measures	91

Part Three

4.10 Implication of Land-use/cover Changes	94
4.10.1 Implication on soil degradation	94
4.10.2 Implication on land degradation	94
4.10.3 Implication on hydrological balance	95
4.10.4 Implication on food security	95
4.10.5 Implication on wild animal destruction.....	96
4.11 Government Rural Intervention in the Study Area	97
4.11.1 The SWC measures under implementation.....	97
a) Graded soil, stone and soil bunds	97
b) Cut-off drains	98
c) Artificial waterways	99
d) Check-dams	99
e) Agro-forestry Practices	99
4.11.2 Planning of the SWC works and actual implementation	100
4.11.3 The plantations on the SWC bunds	102
4.11.4 Observed changes in the land condition since the community based natural resource management intervention	103
4.11.5 Farmers' acceptance and adoption of the introduced SWC technologies.....	104
4.11.6 Factors affecting farm-level adoption of the introduced	

SWC technologies	106
a) Perception of soil erosion as a menace to crop production....	106
b) Households' labor supply.....	109
c) Land tenure security	111
d) Fitness of the Technologies to Farmer Requirements and farming system circumstances.....	113
e) The approach followed in implementing the SWC measures	116
5. Conclusion and Recommendation	120
5.1 Conclusion	120
5.2 Recommendation	122

References

Annex I

Annex II

Annex III

Annex IV

Annex V

SWC technologies	106
a) Perception of soil erosion as a menace to crop production....	106
b) Households' labor supply.....	109
c) Land tenure security	111
d) Fitness of the Technologies to Farmer Requirements and farming system circumstances.....	113
e) The approach followed in implementing the SWC measures	116
5. Conclusion and Recommendation	120
5.1 Conclusion	120
5.2 Recommendation	122

References

Annex I

Annex II

Annex III

Annex IV

Annex V

List of Tables

- Table 4.1 - Demographic Compositions of the Sample Households
- Table 4.2 - Household size and landholdings of households
- Table 4.3 - Estimated average households' incomes from crop production, 1993/4-2007/8
- Table 4.4 - Total number of livestock owned
- Table 4.5 - Number of Oxen owned per household
- Table 4.6 - Items of expenditure and average amount of expenses, 1993/4 - /2007/8
- Table 4.7 - Income- expenditure balances, 1993/4 – 2007/8
- Table 4.8 - Distribution of Respondents by Age Group
- Table 4.9 - Distribution of Households by Family Size
- Table 4.10 -Distribution of Households by Dependency Ratio
- Table 4.11 -Distribution of Respondents by Size of Land Owned
- Table 4.12 -Distribution of Respondents by Labor Force Size
- Table 4.13 -Distribution of Respondents by Farm Equipment
- Table 4.14 -Distribution of Respondents by Livestock Ownership
- Table 4.15- Distribution of Respondents by Financial Capital
- Table 4.16- Distribution of Respondents by Decision Making
- Table 4.17- Livelihood Sustainability Matrix
- Table 4.18- Land-use/cover Dynamics b/n 1993/4 and 2007/8 in Adwa and Lae'lai
Maichew Woredas, Central Zone, Tigray Regional State.
- Table 4.19 - Extent of Land Converted from Each Category to other Land Cover
Category between 1993/4 and 2007/8
- Table 4.20 - Analysis of Land-use/cover Dynamics b/n 1993/4 and 2007/8 in Adwa and
Lae'lai Maichew Woredas, Central Zone, Tigray Regional State.
- Table 4.21 - Factors Contributing to Land-use/cover changes
- Table 4.22 - Land-use/cover Changes Effect to Livelihoods
- Table 4.23 - Land-use/cover Changes Effect to the Environment
- Table 4.24 - Total length and volume of the Rills in Damaged Areas
- Table 4.25 - Estimated Population Size of the Study Area
- Table 4.26 - Distn. of Respondents by Perception about Changes in Population, Forest,
and Soil Fertility (%)
- Table 4.27- Copping Strategies Used by Households during the Last 15 Years
- Table 4.28- Households' Use of Soil Management Mechanisms
- Table 4.29 - Households' Soil Conservation Practices
- Table 4.30 - Livelihood Diversification Category
- Table 4.31 - Total Cost for Resource Management and Development Activities,
1993/4-2007/8
- Table 4.32 - Implication on Food security
- Table 4.33 - Plan for the Construction of the Various SWC Structures
- Table 4.34- Plan for the Production of Seedling and Afforestation and Agroforestry
- Table 4.35 - Actual Implementation of the Soil Water Conservation Plans
- Table 4.36 - Farmers' Perception of Erosion Hazards
- Table 4.37 - Household Size, Land Housing and Labor Condition of Households

- Table 4.38 - Effect of the 1991 Land Redistribution on Individual Holdings and Farmers' Opinions on aspects of Land Tenure
- Table 4.39 - Farmers' Evaluation of the Introduced SWC technologies
- Table 4.40 - Farmers' Participation in the SWC undertakings

List of Maps

- Map 1 - Extent and Intensity of Soil Degradation in Ethiopia
- Map 2 - Adwa and Lae'lai Maichew woredas location map (political)
- Map 3 - Agro-ecological zones of the study area
- Map 4 - 1993/4 Land-Use/Cover Map
- Map 5 - 2007/8 Land-Use/Cover Map
- Map 6 - Gullies Structure between 1993/4 and 2007/8
- Map 7 - Gullies with Elevation Map (1993/4)
- Map 8 - Gullies with Elevation Map (2007/8)
- Map 9 - Gully Density in 1993/4
- Map 10 - Gully Density in 2007/8
- Map 11 - Slope Map of the Study Area
- Map 12 - Elevation Map of the Study Area
- Map 13 - Adwa and Lae'lai Maichew woredas location map (Physical)

List of Figures

- Figure 1 - Area under major cultivation in the study area
- Figure 2 - Conceptual framework
- Figure 3 - Patterns of Land-use/cover Change in Adwa and Lae'lai Maichew Woredas
- Figure 4 - Gully Structures between 1993/4 and 2007/8
- Figure 5 - Mean Monthly Temperature (T) and Precipitation for Adwa Metrological Station (2008)

List of Annices

- Annex I - Slope map of the study area
- Annex II - Elevation map of the study area
- Annex III - Study area map (physical)
- Annex IV - Survey Questionnaire (English version)
- Annex V - Survey Questionnaire (Tigrinya version)

Acronyms

AAU	Addis Ababa University
ADLI	Agriculture Development Led Industrialization
AERE	Atlas of Ethiopia's Rural Economy
CSA	Central Statistical Agency
CZARDB	Central Zone Agriculture and Rural Development Bureau
DAs	Development Agents
DPED	Department of Planning and Economic Development
DRMFI	Dedebit Rural Micro Finance Institution
EDRI	Ethiopian Development Research Institute
FDRE	Federal Democratic Republic of Ethiopia
EFFORT	Endowment Fund for the Rehabilitation of Tigray
FGD	Focus Group Discussion
ILRI	International Livestock Research Institute
LU/LC	Land-use/land cover
OSSREA	Organization for Social Science Research in East and Southern Africa
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resources
MU	Mekelle University
NBE	National Bank of Ethiopia
NGO	Non-Governmental Organization
NMSA	National Metrological Service Agency
PASDEP	Plan for Accelerated & Sustainable Development to Eradicate Poverty
ReST	Relief Society of Tigray
SAERP	Sustainable Agricultural & Environmental Rehabilitation Program in Tigray
SWC	Soil and Water Conservation
TDA	Tigray Development Association
TPLF	Tigray People Liberation Front
TSRG	Tigray State Regional Government
WoARD	Woreda office for Agriculture and Rural Development
WRC	World Resource Center

Acknowledgement

This research could not have been successfully completed without the unreserved and tireless contributions of various individuals and various stakeholder institutions.

First and for most, I would like to express my deepest and heartfelt gratitude to all the sample household heads in the study area for their friendly cooperation and willingness in providing me the relevant information from day one of the research.

I owe a special thanks to Dr. Araya Zerihun and Ato Yissehak Demissie from the Horn of Africa Regional Environment and Network Center (HoA-REC/N) for their role and contribution in securing research funds as part of the Center's initiative to support Demand-Driven Action Research (DDAR). My thanks also goes to the study area Woreda offices for Agriculture and Rural Development (WoARD) along with their Development Agents (DA's) for their role arranging the FGDs, both Woredas' administration bureaus, the Relief Society of Tigray (ReST) and, both the International Livestock Research Institute (ILRI) and the Ministry of Water Resources (MoWR) for their commitment and assistance in providing me the necessary panchromatic aerial photographs of the study area that are very crucial in the analysis of land-use/cover changes.

Finally, it would be a great mistake to skip, if not acknowledge, the various grievances I have been through while pursuing my MA degree in general and particularly when conducting my thesis research deliberately created by outrageous, ill-conceived and hyper critical "scholars". I would like to use this opportunity to send them the following message: I am who and what I am and there is nothing you can do to change that. So, face the bitter fact....Get over with it !

Tekleweiny Ghebremedhin Ghezehegn

June 2009

Abstract

Land degradation, one of the subsequent negative results of land-use dynamics, has become a critical problem in many parts of the Ethiopian highlands. There is great need for rehabilitation and conservation works in such areas. The aim of this study is to empirically assess the magnitude of impact land-use/cover change has on livelihoods and identify changes realized following government rural intervention projects focusing on land management technologies. The analysis of land-use/cover changes involved interpretation of available satellite images of the study area (taken in 1993/4, and 2007/8, respectively). For the assessment of soil loss due to erosion by water, rill erosion, land degradation etc... and its implication on food security, a survey study in the study area was undertaken at the scale of cultivated fields.

Investigation on available data of land-use/cover change indicates that over the fifteen years or so considered, the main type of land use remained agriculture. The major changes observed were the increase in cropland and shrub land areas at the expense of the open grazing and woodland areas. This has implication on runoff generation. The people of the study area are, therefore, facing problems of poverty and resource degradation, which require prudently composed solutions that integrate development and conservation measures.

The newly introduced SWC measures have generally obtained acceptance by the local farmers. They are acknowledged as being affective measures in arresting soil erosion and as having the potential to improve land productivity. Still, their sustainable adoption and widespread replication by the farmers seem less likely. The major factors discouraging the farmers from adopting the introduced soil and water conservation technologies on their farms were found to be labor shortage, land tenure uncertainty and problem of fitness of the technologies to the farmers' requirements and the farming system circumstances. Though it was claimed that participatory procedures were followed, facts on the ground did not seem to support this. The study which started in May 2008 and ended in July of 2009 concludes by suggesting some measures that should be taken to enhance adoption and widespread replication of the conservation technologies by the farmers and ensure sustainable land-use in the area.

CHAPTER I

1. INTRODUCTION

1.1 Background Information

Human history has shown that the reduction/loss of biodiversity when combined with land degradation which occurs as a result of poor land use practice has the potential to threaten the prosperity of local civilizations. Already, the scale of biodiversity loss caused by the present human activity ranks with the great prehistoric extinction. Recovery from this level of disturbance may require tens of decades of years (World Resource Center, 1980).

Deforestation and soil degradation have been major problems for quite a long time with serious consequences to Ethiopia. Soil degradation especially has not only been a continuous threat; but also is now more serious than ever before. It is serious in its severity, its extent, and the rate at which it is progressing. Estimates by the Atlas of Ethiopia Rural Economy (1998) show that around 52% of the area in Ethiopian highlands is affected by various degrees of soil degradation, half of which is described as very severe. The study further warns that if the process of soil degradation is allowed to continue at the present rate, one-half of the total area of the Ethiopian highlands will be completely unsuitable for crop production at some point within the next two decades.

Soil erosion is considered to be the major cause of soil degradation in Ethiopia. Process of soil degradation is initiated and aggravated in particular by deforestation, over cultivation, overgrazing and over population, and also by socio-economic and political factors directly related to rural development. Human activity puts enormous pressure on the land especially when the agricultural system is characterized by a low level of external inputs such as fertilizer, pesticide, etc. In a predominantly agrarian society like Ethiopia, soil degradation is one of the ominous threats to food supply. As a consequence of soil degradation, the production capacity of the Ethiopian highlands is being greatly undermined. It is estimated that productivity is declining at a rate of 2-3% annually (Hurni, 1998). This poses a serious threat to the national food supply which at present is

hardly adequate for self-sufficiency. Recurring famine in Ethiopia has been attributed, among other factors, to land degradation.

The Ethiopian highlands saw probably the most extensive soil conservation activities in Africa in the 1970s and 1980s. During this period an attempt was made on the part of the government to tackle the land degradation problem through afforestation, hillside closure and terracing activities. The conservation measures that were newly introduced and widely applied on cultivated fields in the Tigray central highlands were terracing (locally known as '*gidib*') and normal bunds. These structures are normally constructed by digging ditches along the contour in the case of level bunds, and at a slight angle to the contour in graded bunds. The ridges are constructed by throwing the soil uphill in the case of the '*gidib*' and downhill in the normal bunds. The policy adopted in Ethiopia was to construct bunds at zero gradient, that is, along the contour, because of difficulties anticipated on laying out the graded ones (Belay, 1998 a).

However, the Ethiopian soil conservation program failed to win acceptance by the land users because of its multifaceted limitations and constraints (SIDA, 1984; Dessalegn, 1991; Belay, 1992a). Most of the limitations of the conservation program are attributed to the fact that the newly introduced conservation structures were applied before they were adapted to the environment and farming system. The acceptability of soil conservation program is very much increased where they incorporate indigenous soil and water conservation (ISWC) practices as these are very well adapted to the local ecology and farming system (Critchley *et al.*, 1994; DeWalt, 1994; White and Jickling, 1995; Pretty and Shah, 1997). When modern conservation programs are built on indigenous practices, their dissemination is faster, more widespread, and cheaper because they fit better into the local environment and socio-economic conditions (Reijntjes, *et al.*, 1994; Van Dijk, 1997). Thus, to be acceptable and sustainable the technologies recommended by the Ethiopian soil conservation program should incorporate the indigenous erosion control practices of the various agro-ecological zones through participatory and adoptive research.

A field survey carried out in the south Wollo zone of Amhara Region located in the north central highlands of Ethiopia revealed that one of the indigenous soil and water conservation technologies, the *weber*, has many features that can be improved and applied for sustainable conservation of soil resources. However, there are no published materials on the technology, despite its promising features (Belay, 1992).

One of the regions in the northern highlands of the country which have fallen victim to the soil degradation as a result of poor land use practices is the Tigray Regional State. In Tigray, the severely degraded lands can be typically characterized by heavily eroded or nutrient deficient soils, hydrological instability, reduced primary productivity and loss of biological diversity. Past reforestation programs in such areas have been unsuccessful due to either total failure or low survival rate of planted species (ReST, 1998). In Tigray, rainfall intensity is high at the beginning of the rainy season when the ground is left bare and soils are highly exposed to erosion. Soil erodibility is also relatively high as a result of low organic matter content of much of the soils in Tigray. The rugged topography and steep slopes of Tigray also leads to high erosion rates. Vegetative cover is largely determined by human activity, though there is still substantial debate about the extent of natural vegetative cover in northern Ethiopia. Although an estimate that 40% of Ethiopia's land area was covered by forest at the turn of the 20th century is commonly cited (e.g., Berhanu, 1998), recent archeological work has found evidence of heavy deforestation in the northern Ethiopian highlands as long as 500 years ago (Hans Hurni, personal communication). Nevertheless, there may have once been natural vegetation covering much of Tigray, even though the deforestation may have occurred much further in the past than many people currently believe. This is consistent with the vegetation still observed in protected areas and churchyards in Tigray and with the rapid regeneration of vegetative cover being seen in area enclosures. Thus, the lack of vegetative cover and its contribution to soil erosion appear to be primarily human-induced. Wind erosion is also determined largely by wind velocity, soil erodibility, topography, vegetative cover, and farmers' management practices (particularly with regard to windbreaks). High winds in much of Tigray cause wind erosion to be a serious concern, although this has not been considered to the same extent as water erosion. The rugged topography of Tigray causes

winds to vary substantially across locations. More information is needed on the extent of wind erosion and its impacts in Tigrai.

To circumvent these problems, communities have started to limit interference of people and domestic animals in certain degraded areas, and improving their land use practices with the hope of preventing further degradation. The regional bureau of agriculture and natural resources, and other development partners in Tigrai like the Relief Society of Tigrai (ReST) have widely reported to have started to avert the land degradation process in the region through massive efforts on soil and water conservation activities, including the establishment of enclosures (areas fenced in to keep out animals or intruders), with the active involvement of local communities which would in turn offer the desired socio-economic benefits as well as environmental services (Medhane, 1997).

Mountain environments consisting of fragile and delicate ecosystems require careful, agro-ecologically sustainable management, as they are prone to extreme intervention. Intensification of land use in response to increased human and livestock population can have adverse effects on the environment. The Tigrai highlands in north Ethiopia are an example of this phenomenon (Medhane, 1997; ReST, 1998).

1.2 General Characteristics of the Study Area

1.2.1 The Physical Environment

A. Location

Adwa and Lae'lai Maichew woredas are located in Central zone of the Regional State of Tigrai (with the town of Axum being the capital of the zonal administration and found within the Lae'lai Maichew woreda; *see* Map 2 and 13). Situated at some 1055kms and 1080kms north of the capital Addis Ababa, and 250kms and 275kms away from the regional capital Mekelle town, respectively. The site is geographically located at $390^{\circ} 50' - 390^{\circ} 60'E$ and $130^{\circ} 70' - 130^{\circ} 81'0 N$ and covers a total area of 71,330 ha. The two woredas have a total of 24 sub-woredas, locally known as *tabyas*, of which 15 belong to Adwa woreda and the remaining 9 to Laelai Maichew (Axum) woreda. The total population of the two woredas is estimated to be 275, 018 including the woredas towns' population

(CSA census, 2008). The two adjacent woredas are part of severely degraded and continuously degrading land, which will be representative of the conditions in large parts of the locally known *Woina-degu'a* climatic and agro-ecological belts of the northern highlands. Besides, the study area used to be part of the highlands that are considered self sufficient producing regions of the country, but presently threatened by resource degradation and impeding food insecurity (ReST, 1998).

B. Geology, Physiography and Soil

In terms of geology, the study area is part of the highlands that have derived the greatest proportion of their heights from the uplifting of the Arab-Ethiopian landmass and the subsequent outpouring of basaltic lava flows during the Tertiary period, commonly known as the Trappean lava. This thick basalt layer is underlain by sedimentary rock the Mesozoic age, which is in turn underlain by the basement complex rocks of the Precambrian (Mohr, 1971). The physiography of the study area reflects its geology and geological history. The uplifting force crated an initial elevated landmass, and the subsequent outpouring of basaltic lava provided a thick protective cap and added on to the elevation. The resulting landmass within the bounds of the watershed has now an elevation ranging from 2420m to 2500m a.s.l. This structural landscape has been subjected to geomorphic processes over the geologic time to the significantly re-shaped. Currently, steep slopes and undulating topography characterize the study area.

Physiography can create both opportunities and constraints to development. For instance, around the study area, the higher elevation influences air movement and contributes to the occurrence of higher physiographic rainfall. The elevation gradient and the associated climatic conditions allow cultivation of a wider range of crops and the high altitude offers a favorable environment for human habitation, which is free from tropical pathogens. On the other hand, the irregular surface created by frequent and deep dissection constitutes a major barrier to communication and impedes, in one way or another, agricultural and infrastructural development. Also, the steep slopes and rugged terrain constitute natural hazards with respect to soil erosion. Under such physiographic conditions, even rains of moderate intensity are enough to cause massive erosion and make soils shallow and stony.

The soil of the study area can be generally classified into two groups based on color: reddish soils and grayish soils. The reddish soils occur on steeper slopes, which are well-drained. They are derived from complete decomposition of the volcanic lava flows by deep tropical weathering in situ. These soils have been deeply leached and are moderate to low in natural fertility and with some level of acidity. The grayish soils occupy alluvial valley floors. These are deep, grey to dark in color, and largely fluvial sediments or washed down from upland areas. They are apparently fertile soils. The nature and properties of soils such as texture, aggregate stability, shear strength, infiltration capacity and organic matter and chemical contents, which are interacting in a complex manner, constitute an important factor affecting the susceptibility to detachment and transport (erodibility) of the soils by the forces of erosion (Morgan, 1995). Organic matter content and textural composition can be considered the most important, as these influence all the other soil properties.

C. Climate

According to the simplified traditional agro-climatic classification system, which considers only temperature and altitude, the study area lies within *woina-degu'a* zone. The climatic condition is generally humid. As measured at Adwa town, for example, (10°s0'N 37°40'E and elevation 2411m a.s.l.), mean annual temperature is 14.5°C with a range from 13.2°C in July and August to 17.3°C in March. Average annual total rainfall is 1300mm. The rainfall pattern is unimodal, with a rising limb starting in May and reaching to a peak between July and August. More than 75% of the total rain falls in June, July, August and September (locally known as *kiremti* season; else where known as *kiremti*). It is in this season that the major agricultural activities such as plugging, sowing and weeding are carried out in the study area. At the national level as well, some 85 to 90% of the harvests are due to the *kiremti* rains (Woldeamlak 1998). The dry months are November, December, January and February (locally known as *hagai* season; else where known as *bega*), when less than 5% of the annual total rainfall occurs. Since the watershed lies at a higher elevation than Adawa, temperatures must be slightly lower and rainfall higher than these values. Average annual total potential evapotranspiration (PET), as estimated by the Thornthwaite's (1948) method, is 855.7mm. It reaches a peak in

March, matching with the temperature pattern but generally with a very low monthly variation. The monthly rainfall exceeds the calculated PET only in June, July, August and September. In the rest of the months, PET exceeds the rainfall. The uneven distribution of the rainfall gives rise to a serious shortage of water even for domestic consumption purposes during the dry season.

1.3 Statement of the Problem

Over the past few decades, the agricultural sector has failed to keep pace with the growing demand for food. This is partly attributable to erosion-induced degradation of croplands directly related with land-use/cover changes. On the other hand, efforts of soil and water conservation made over more than two decades ended up with disappointing results. The problem has therefore persisted and will persist as a serious threat to the food security and development envisioned in the country's policy documents. Thus, soil and water conservation is fundamental to the future of the Ethiopian economy. This is more so in view of the overall economic development strategy the country is currently pursuing namely, Plan for Accelerated and Sustainable Development to Eradicate Poverty (PASDEP) which is a short term plan adopted from the comprehensive overall development strategy: Agriculture Development Led Industrialization (ADLI).

Failure of previous attempts to addressing land-use/cover changes, or land rehabilitation activities in general for that matter was largely because of the misguided nature of interventions: it disregarded local level biophysical and socio-economic realities. This is essential because land degradation as a process varies from one area to another, and farmers' conservation behavior varies across socioeconomic groups. In there words, the planning of effective and efficient land management technologies that will be accepted by farmers requires empirical understanding of the extent, magnitude and rate of land-use/cover change that causes a massive land degradation, and the diverse socioeconomic variables affecting farmers' conservation decisions. This study was set out of assess the magnitude and rate of land-use dynamics, and analyze the local farmers' acceptance and adoption of newly introduced conservation technologies in the two neighbor woredas, namely Adwa and Lac'lai Maichew, in central zone of the Regional State of Tigray. By

the time of the study, there was intensive soil and water conservation intervention in the study area by the woredas' agricultural offices with technical support from the local NGO called the Relief Society of Tigray (ReST). The intention of the intervention was not only to rehabilitate the degraded landscape, but also to use it as a representative experimental and demonstration site from which the farmers in the surrounding would adopt/adapt conservation technologies. On the other hand, in this part of the country, there is dearth of information on resource degradation and farmers' circumstances.

1.4 Objectives of the Study

1.4.1 Main Objective of the Study

The main objective of the study is:-

To assess/examine land-use dynamics and its implication on household livelihoods.

1.4.2 Specific Objectives of the Study

The specific objectives include:-

- i) Identify the potential influence land-use change has on food security in the study area.
- ii) Assess the impact of land-use on soil and its impact on productivity.

Studying land-use changes brought as a result of government rural intervention in the study area over the last 15 years.

1.5 Significance of the Study

The dependence of the Ethiopian economy on land resource is evident from the disproportionately high contribution of the agricultural sector. The sector is also given particular emphasis for the overall future transformation of the national economy. Presently, the pillar strategy of economic development is Agriculture Development Led Industrialization (ADLI). The success of this strategy depends, among other things, on the sustainable utilization of the land resource. Thus, the current trend of land degradation is a menace to the viability of the national economy. The need for its reversal is, hence, very important. Accordingly, studies pertaining to evaluation of processes, extent, causes and cures of land-use/cover changes are significant. The study is hoped to make a contribution along this line. An underlying premise of the study is that there is

insufficient empirical and local-scale understanding of land degradation and land users' conservation behavior, leading to providing only partial solutions and subsequent failures. By clarifying the severity and rate of land-use/cover changes' and their implications on livelihoods in the study area and identifying factors affecting farmers' land conservation decision-making processes, the study hopes to highlight more promising approaches to intervention. The study also has a wider relevance of revealing some policy implications. The fact that the land-use/cover change studies carried out in the study area are very limited and very little or no issues have been discussed on the reports despite the fact that land-use change has enormous impact on livelihoods substantiates the study's significance.

As mentioned earlier, studies dealing with issues of land-use/land-cover changes are generally rare in the country, and so far only a few of these have been carried out in the whole of the northern highlands. Further more, the study hopefully will fill the existing research gap and serve other researchers as a document to carry out similar studies on the issue and discover new findings.

1.6 Scope and Limitation of the Study

The research tries to examine the implication of land-use dynamics on livelihoods in two neighboring woredas (namely, Adwa and La'elai Maichew) in central zone of the National Regional State of Tigrai. Despite the fact that the selected topic is linked with many other issues, the study merely focuses on how livelihoods are affected as a result of changes brought about in land-use practices in the study area. There are a total of 24 sub-woredas (*tabyas*) in the two neighboring woredas and all *tabyas* are included in the study. A proportional simple random sampling technique is applied for the fact that there is a homogenous population. A total number of 125 households are drawn for the study where each sub-woreda's (*tabya*) share are 5 randomly selected households with even further proportional distribution to the next administrative village level (locally known as *kushet*). The remaining 5 farm households are a reserve for possible drop outs. For reasons of time and budget constrains, however, the study is restricted to limited area coverage and sample size (only 2 woredas and 125 households). Secondly, the analysis is

made based on the households own information of various estimations like crop production and average income (may not necessarily replace a standard and official figure). Thirdly, the study is based on one time survey and could not capture the variability climate at different times, harvest etc... Lastly, there was a serious shortage of empirical studies related to the thesis topic conducted in the study area. Even of those very limited available, very little or no issues have been discussed on the reports concerning the enormous impact land-use/cover change has on livelihoods.

1.7 Organization of the Study

This thesis is organized in five chapters. The first chapter deals with introduction, background information, objectives of the study and general characteristics of the study area. The next chapter deals with literature review including land-use/cover change along with its potential causes, soil erosion and land degradation, land-use/cover change, agriculture and implications on livelihoods. The third chapter presents the research methodology, methods of data collection, data sources and materials and data analysis. Chapter four presents analysis and discussion of data collected from sample households in the study area thoroughly. It also includes analysis of image data which was acquired from interpretation of 1:50,000 panchromatic aerial photographs taken in 1993/4 and 2007/8 used to create the spatial databases needed for the evaluation of land-use/cover change assessment. The last chapter concludes the findings and forward some recommendations based on the study result.

CHAPTER II

2. THE LINKAGE BETWEEN LAND USE CHANGE AND LIVELIHOOD

Land affects several activities of man and its terrestrial productivity. Topographic, soil, vegetation and water resource characteristics determine use of land for different purposes (FAO, 2005). To the full exploitation of these resources, humans are continuously changing and modifying land uses. This implies that the use of land has variability both in space and time. Changes in land-use/land cover affect the status of land resources and thereby its actual and potential productivity and suitability of the land for uses. Most global land use changes are from natural vegetation to agricultural and settlement uses (FAO, 2001). A loss in natural protective cover of land causes degradation of soil and water (Woldeamlak, 2003) as well as wildlife resources (Mohammed, 2006).

Existence of historical land use changes for any geographically defined area can be studied from historical analysis of series of satellite images and aerial photographs (FAO, 2005). This approach can help inferring about past and present and predict future status of natural resources including forest, soil and water. Hence, it is used in evaluating land degradation occurring in response to land use changes and patterns (Morgan, 1986). In Ethiopia, extent of land degradation is strongly associated with removal of vegetation cover for farming, settlement, fuel and construction purposes (Hurni, 1983; FAO, 1994; Aklilu, 2006).

Analysis of series of aerial photos and satellite images reveals that at about 1900 natural forests covered nearly 40% of the highlands of Ethiopia (Daniel, 1988). However, this extent of forest cover was reduced to 3% in the early 1980s (EFAP, 1994), 4.5% in 1990s and 4.2% in 2000 (FAO, 2001). Local level studies conducted in some parts of Ethiopia show great variability on impacts of land use changes on land degradation. Available information indicates that up to 25% in South Central highlands of Ethiopia (Muluneh, 2001), from 12 to 41% in the Simen Mountains (Amare, 1996), about 53% in the Central West Ethiopia (Selamyihun and Tekalign, 2003), close to 98.9% in North Western

Ethiopia (Gete, 2000) and 80% in eastern highlands (Mohammed, 2006) of the forest land was transformed to cultivated land in 3 to 4 decades. In Beressa watershed of Central Ethiopia, natural forest land decreased from 14.8% in 1957 to 2.4% in 2000 (Aklilu, 2006). As a result of such transformations, land prone to land degradation mainly through processes of soil erosion increased over time. For instance, 56.5% to 73.2% in parts of eastern Ethiopia (Mohammed, 2006) and 70 to 73% in parts of North Western highland Ethiopia (Woldeamlak, 2003) was exposed to soil erosion in nearly 3 decades due to a loss in natural cover of the land. Moreover, some studies indicate that nearly 95% of formations of gullies occurred in cultivated lands (Mohammed, 2006), indicating the severity of land degradation in such land use patterns. In western parts of Ethiopia soil fertility decline was observed due to a land use change from natural vegetation to cultivation (Solomon, 1994). These studies substantiate that existing land use changes have important implications for land degradation and, consequently, great implications for subsequent land use change.

Ethiopia is one of the poorest countries in the world. The agricultural sector contributes disproportionately much to the national economy. It accounts for some 80% of employment, 85% of export revenue and 45% of the GDP (FAO, 1993). Most of the total national agricultural produce is generated by the subsistence-oriented farmers, who are cultivating micro-holdings with impoverished soil on sloping and marginal lands. These smallholders constitute the poorest and largest segment of the population whose livelihoods directly depend on the exploitation of the natural resources. They operate with obsolete agricultural technologies and with livestock playing the key role in the production process. The basic nature of the agricultural production is thus exploitative without sufficient use of ameliorative inputs, which is undermining the sustainability of the life support systems.

The pressure on the land resource is more severe in the highlands (> 1500 m.a.s.l) of the country, constituting some 45% of the total area. The highlands accommodate some 88% of the human and 75% of the livestock populations, and constitute about 95% of the regularly cultivated lands (FAO, 1986). These highlands have, in deed, been settled for

millennia, and agriculture has a matching history. Currently, the highland farming population grows with a rate of around 3% per annum, and correspondingly the livestock population is increasing. These place more demand on more marginal land for cultivation and grazing uses, leading to more devegetation and degradation. The de-vegetation and degradation of the grazing lands create shortages of fuel wood and animal feed, forcing the rural poor to divert dung and crop residues from their traditional roles as soil nutrient to burning for fuel and feeding livestock. Coupled with many other psychical, socio-economic and political factors, these conditions are leading to degradation of the natural resource base. Of the forms of resource degradation, expansion of cultivation into steep land areas at the expense of natural vegetative covers and soil erosion by water are the most damaging.

Many empirical studies conducted in different parts of the country have reported that croplands expanded into marginal areas at the expenses of natural vegetation covers. For instance, a significant increase in cultivated land at the expense of forestland was found to have occurred between 1957 and 1995 in the Dembecha area, northwestern Ethiopia (Gete and Hurni 2001). A rotational land-use/cover involving cultivation and vegetation (forest and bush) was found to have occurred between 1957 and 1982 in the Metu area, southwestern Ethiopia (Solomon, 1994). Increases in the farming compounds were reported for the Mafud escarpment around Debre-Sina, central Ethiopia, between 1957 and 1986 (Tesfa and Norman, 1995). Belay (2002) has reported a significant increase in the cultivated land at the expense of natural vegetation cover between 1957 and 1986 in the Derekolli micro watershed in south Wollo, north-central Ethiopia. Such expansions of cultivation, commonly into steep land marginal areas without putting in place necessary soil and water conservation measures, lead to loss of soils due to erosion.

Soil erosion by water is by far the biggest problem in Ethiopia. According to (Hurni, 1993), national average soil removal is around 1943 million tones per annum, but with magnitudes as high as 300 /that/ year measured at individual fields. On cropped lands, the same study has estimated the average soil loss rate at 42 t/ha/year or 4 mm of soil depth, which is sufficient to wear away the total soil profile within 100-150 years (Assuming average soil depth of 60cm in the highlands). In economic terms, soil erosion is estimated

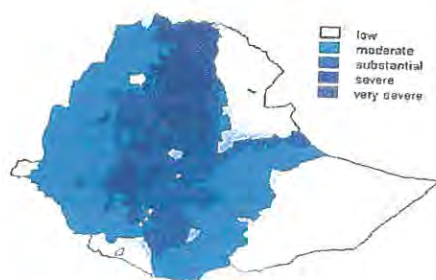
to lead to productivity loss of 1 to 2 percent per annum; while use of crop residues and dung, by contributing to biological degradation of the soil, is estimated to lead to a further 1 percent per annum decline in agricultural productivity (Hurni, 1993). Erosion and biological deterioration of soil has implications on the country's structural food insecurity problem. With shallow and degraded soils, rainfall infiltration is severely reduced, moisture and nutrients storage capacity is strongly depleted, growth of vegetal cover becomes poor and the resistance to erosion significantly decreases- the process thus becoming self-accelerating. These conditions simply exacerbate effects of droughts and amplify variations in crop yields, thereby contributing to the famines.

The issue of land degradation and conservation was given a serious attention following the change of government in the early 1970s. Since then, considerable efforts have been made to tackle the problem. The largest of all was that carried out between 1976 and 1988 with assistance from international community, particularly by the World Food Program (WFP). Over this period, 800,000 km of soil and stone bunds and 600,000 km of terraces were installed; 500 million tree seedlings were planted; 100,000 ha of degraded lands were closed for natural regeneration; and check dams were constructed along gullies of tens of thousands of kilometers long (Daniel, 1988; Wood, 1990). This environmental rehabilitation endeavor was described as "impressive" by some and "astonishing" by others (Daniel 1988; Wood 1990). Yet, the area covered by these rehabilitation and conservation works was estimated at only 7% of the total that needed treatment. With this rate, it was estimated that all the area awaiting treatment could take some seven decades (Berhe and Chadhokar, 1993).

Map 1

Extent and Intensity of Soil Degradation in Ethiopia

(Source: Hakkeling, 1999)



Even worse is, however, that the reported achievements were later evaluated as ineffective, insufficient and unsustainable (Stahl, 1990; Yeraswork, 2000). The whole effort was, therefore, largely a failure due to number of factors. The most important factor is said to be the top-down policy approach pursued in the implementation processes, which made the conservation works unattractive on the part of the farmers. That is, due consideration was not given to understand locale-scale factors that would affect farmers' acceptance and adoption of conservation measures at the farm level. In the study area, as in the rest of the country, there was an extensive attempt for land conservation with a similar implementation process, which was then unsuccessful. A lasting solution to the problem evidently requires a new approach in which there is a genuine involvement of the direct-land users, i.e., the subsistence farmers. Thus, a clearer understanding of the magnitude of land degradation and local-specific socio-economic and institutional factors influencing farm-level conservation decisions is necessary.

2.1 Land-Use/Cover Changes

Accurate information on land-use/land-cover changes and the forces as well as processes behind are essential for designing a sound environmental planning and management. Land-use/land-cover analysis provides the baseline data required for proper understanding of how land was used in the past and what types of changes are to be expected in the future. Studies of land-use/land-cover changes also yield valuable information for analysis of the environmental impacts of human activities, climate change, and other similar forces. Such analysis is of great use to the resource manager because it provides information that would help in resolving conflicts between human use of natural resources and the function of natural systems. A change in land-use/land-cover can negatively affect the potential use of an area and may ultimately lead to degradation and loss of agricultural productivity (Pyrovesti and Karteris, 1986).

Studies relating to land-use and or land-cover changes are rare in Ethiopia, and so far only a few of these have been carried out in the whole of the northern highlands. Such studies include the works of Woien (1995), Gete (1997), Crummey (1998), and Kibrom and Hedlund (2000). The studies of Woien (1995) and Kibrom and Hedlund (2000) were

based on black and white aerial photographs of the 1957 and 1986. The former assessed changes in woody plant cover and farming compound distribution in an area of about 70 km² on the Mokoni escarpment surrounding Maichew town, in South Tigrai and reported a considerable increase in the area of the woody vegetation. On the other hand, Kibrom and Hedlund evaluated changes in nine land-cover categories in an area of 110 km² in Shire district of Western Tigrai, and reported a major decline in shrub land, major increments in open areas, but a very little change in the cropland.

Crummey (1998) based his analysis of vegetation change by sets of ground photographs taken in 1937/1940 by Armando Maugini (Director of the Instituto Agronomico d'Oltremare of the University of Bologna), and he himself in 1996. Maugini's photographs were taken in different parts of North Wollo and its neighboring southern Tigrai (Raya) regions to generate data for the evaluation of land for Italian settlement and agricultural development. Crummey strongly argues that these photographs invariably suggested that the area was covered with lesser tree and woody biomass in the 1930s than the 1990s. He also concludes that there is very little change in the total area and spatial distribution of the cropland in the last 60 years. The study of Gete (1997), conducted in an area of 27, 000 ha in Hawzien area of eastern Tigrai zone, was based on black and white photographs of the 1957 and 1982 and a Landsat image of 1995. The results suggest that there is a major contraction of the forest cover and expansion of cropland, particularly, between 1957 and 1982. Most of the above studies covered similar periods but were conducted in different agro-ecological zones and environments, and as a result, the findings not only differ but in some case conflict, thus demanding further investigation.

2.2 Causes of Land-Use/Cover Changes

Land-cover changes are not only cumulative in nature but also the result of a number of interacting variables and processes. The distribution of various land-cover and land-use types are primarily controlled by factors such as slopes gradient, soil depth, terrain configuration, and the demand for fuel wood. Most of the cropland is found in the plains constituting the middle and lower reaches of the study area, although most of the slopes on the mountainous terrain to the north are also under intensive cultivation. A

considerable proportion of the cropland expansion that took place between 1957 and 1986 appears to have taken along the valley rims in the middle and lower reaches of crop production primarily because of the rugged terrain, very steep slopes, and shallow soils. The presence of the patches of natural vegetation along the western and northern slopes is also attributed to the same factors (Belay, 1998).

A group of interacting variables are responsible for the drastic decline of the shrub land and the gain of the shrub-grassland and grassland despite the generally expected overgrazing by livestock and subsequent bush encroachment. The first of these is the extensive use of the woody vegetation for charcoal production and firewood. The study conducted by Mengistu (1998) very well confirms the fact that the major cause for the extensive destruction of the shrub land in the region is firewood collection and charcoal production for the surrounding markets. It should be noted that charcoal, which causes more destruction of woody biomass than firewood, is produced primarily for markets in the surrounding towns. Several studies indicate that the population of the major zonal towns (Adwa, Axum, Adi'Abun, and Enticho), which constitute the largest charcoal consumers, increased by mean annual rates of 10.4 and 13.5 per cent between 1960 and 1986, and 2000, respectively, exerting severe pressure on the shrub land. It should also be noted that there was a three-fold increase in the total population of the country since 1950 (CSA 1985 and 1988), and things are not expected to be much different in the study area. Thus, the accelerated rate of shrub land destruction exponentially with population growth in areas where the population is dependent on wood for fuel (Mwalyosi 1992: Anderson and Fishwick 1984).

A study by the Relief Society of Tigray (ReST, 1998) states that the production of charcoal and fire woods for markets in major towns has become a large-scale problem in the regional state (*kilil*) which eventually may lead to desertification. Arid and semiarid areas, known as drylands, account for one-third of Tigray's total land area and support a combined population of about 3.4 million people (of which about 48 percent are in central zone where the two neighbor woredas are located). Soil degradation reduces crop output and is a major concern economically. About 70 percent of drylands in the region

are susceptible to degradation, 50 percent have been degraded to some degree, and 15 percent show extreme degradation where agricultural yields are less than half of their former level. Almost all the areas of extreme degradation are in the Central zone, Eastern zone and in the newly formed Southeastern zones of the region. A study on land-use/cover changes in Shire district (about 60 kms west of the study area) by Kibrom Tekle and Lars Hedlund (Kibrom, T. 2000) indicate that over the twenty-five years considered, the main type of land use remained agriculture. The major changes observed were the increase in cropland and shrub land areas at the expense of the open grazing and woodland areas. This has implication on runoff generation, erosion survey indicate that, assuming a 30% contribution from inter-rill erosion, the rate of soil loss was around 37 t/ha/year, exceeding the rate with which soils could be formed in the area. The people of the study area are, therefore, facing problems of poverty and resource degradation, which require prudently composed solutions that integrate development and conservation measures.

2.3 Soil Erosion as a Consequence of Land-Use/Cover Change

One of the immediate impacts of the thinning and destruction of the shrub land is shortage of fuel wood and construction materials for the farming community. This condition forces farmers not only to travel very long distances to collect wood, but also to increasingly burn crop residues and organic manure for cooking and heating. The latter has severe consequences for the fertility of the cropland as the action leads to depletion of the organic matter in the cultivated soils. The reduced possibility for cropland expansion and severe shortage of land has also its own impact. The shortage of land has compelled farmers to practice continuous cropping and completely abandon even seasonal fallowing. Field observations and informal discussions with farmers by the author (February, 2008) as well as reports from indigenous NGOs working in the study area (like ReST) suggest that cropping intensity in the study areas have been raised to almost 100 per cent. Such continuous cultivation in a situation where little organic matter returns to the soils leads to severe soil erosion and land degradation. This in turn negatively affects efforts to boost agricultural production and productivity whose end result is obviously serious food insecurity. Furthermore, shortage of cropland has forced farmers to cultivate steep slopes and shallow soils that are vulnerable to degradation.

Previous studies carried out in the study areas by local NGO's such as ReST (1998) indicate about 14 per cent is marked by slope gradients of above 27 per cent while 4 per cent is marked by slope gradient of more than 47 per cent (Belay 1998).

Both Adwa and Laelai Maichew (Axum) woredas share a similar agro-ecology and an average annual rainfall ranging from 801-1,200 mm (NMSA, 2002; table 1), although variability of rainfall from year to year is very considerable. The rainy season is mainly between June and September. The average annual temperature at the study site ranges from 15 to 18 °C and it belongs to the '*weinadagu*' a traditional agro-climaticological zone characterized by a hot to warm semi-arid climate.

The soils in the study area are mostly developed under arid conditions where the weathering process is slow, as a result very shallow lithosols developed (TFAP, 1996). The locally named soils, such as "*Tsaeda Ba'ekhel*" (Eutric Leptosols) and "*Walka*" (Eutric Vertisols) belong to these soil types. Eutric Vertisols constitute clay soils that swell when wet and contract as well as crack when dry. The heavy texture of these soils provides high water holding capacity and allows the soils to store sufficient water for growing plants. The Vertisols are also sufficiently fertile for healthy growth and development of crops. Leptosols on the other hand are shallow soils mainly found on the ridge crests, backslopes and upper footslopes. The Eutric Cambisols and Eutric Regosols are deep loamy soils with very good fertility and excellent drainage and moisture holding capacity. Unfortunately, these soils cover only a very small area of land in the study area. The Eutric Cambisols constitute intergrades between the Vertisols and Cambisols and show the characteristics of both these soils. They display shallower A – horizons, lighter color, lower clay content, better drainage, and narrower and shallower cracks compared to the Vertisols.

Soils in the study area and the central highlands of the region, as a whole, also are generally vulnerable to accelerated erosion because of the combined effects of intensive rains and sparse vegetation cover. An analysis of daily rainfall records at Adwa meteorological station, in which one of the study areas is located, showed intensities of

up to 140mm per hour for altitudes of less than 1800 m i.e., areas below 100 mm per hour for those above 1800 m (FAO, 1965; Constable, 1984). This is in line with the pattern observed through out the tropics (Hudson, 1995). In areas of lower rainfall (< 500 mm), the amount and intensity of the rains is too low to cause major erosion damage; and in regions where rainfall is above 1000 mm, the rainfall intensities are lower and the soils are also very well protected by presence of a dense vegetation cover (Hudson, 1995). Where rainfall is intermediate, i.e., 500 to 1000 mm per annum, more erosion takes place because not only the rains are more intensive, but also the soils are poorly protected by the thin vegetation cover. The vulnerability of cultivated soils in the study area and its environs is further aggravated by the steep slopes and shallow soil depths. Because of the severe shortage of land, farmers have not only abandoned fallowing but also cultivate the very steep slopes with very shallow soils. A capability classification based on slope and soil depth shows that only 47 per cent of the cropland can be cultivated through use of contour ploughing and broad-based terracing as currently practiced in the two neighbor woredas.

2.4 Agriculture and Land-Use

Agriculture, in which subsistent rain-fed crop cultivation is practiced, supplemented with some livestock production, constitutes the basis of the economy of the study area. Crop cultivation is carried out on land ranging from gentle to very steep slopes. Estimates show that of the total cultivated land in the study area woredas, 54 per cent is marked by slope gradient of above 12 %, 14 per cent by more than 27 %, and 4 per cent by more than 47 % (Belay 1998a).

Although different types of crops are cultivated, the most predominant one is barley (*Hordeum vulgare*). The latter is most widely cultivated because of its high potential photosynthetic rates and efficient water use (Norman, Pearson; and Searle, 1984). Another reason for the much wider cultivation of this crop is its lesser labor requirement. Farmers prefer to cultivate crops that have lesser labor requirement in areas where the risk of drought is higher (Rothenberg, 1980). This crop has also the capacity to remain dormant during a dry spell and resume growth when there is additional rainfall. In almost all cases, sorghum is cultivated mixed with crops such as sesame (*Sesamum indicum*),

nigger seed (*Guiztia abyssinica*), haricot beans (*Phaseolus vulgare*), and maize (*Zea mays*). The primary objective of mixed cropping is to increase the variety and quantity of food produced in the short growing season. However, farmers also plant the various types of pulses within sorghum fields to improve the soil fertility, to reduce the risk of the total crop failure and increase their income. Taff (*Eragrostis teff*) is also cultivated over a considerable area throughout the two neighbor woredas. Vegetables and fruits such as onion (*Xemao edulis*), green and red pepper (*Capsicum spp*), banana (*Faluus levus*), potato (*Catha edulis*), tomato (*Petit edulis*), and various spices are also cultivated as cash crops, but these are planted on a very small portion of the arable land.

Indigenous soil conservation measures, comprising agronomic and biological measures, are extensively applied in the woredas. Agro-forestry is also another important component of the farming system. The trees that are commonly integrated in the cropping system are *Accacia spp* (girrar), *Ziziphus spina-christi* (kurkura), and evergreen shrub lands such as *Euclea schimperi*, *Myrsine Africana*, *Jasminum grandidlorum*, *Dodonia angustifoia*, *Pterlobium stellatum*, *Cadia perpurea*, *Calpurnia aurea*, *Rhus natalensis*, and *Diospyros abyssinica*. More than 80 per cent of the cultivated land is also treated with the main indigenous structural soil or stone bunds and terraces that develop from narrow strips of land left under grass or stone lines, however, are intended not only to control erosion but also to conserve moisture.

Figure 1

Area under Major Land-Use Categories in the Study Area (2007)		
Land-use/cover	Total Area (ha)	Per cent of Total Area
Cultivated Land (arable)	38,000	97
Grassland	154	0.39
Shrub-grassland	258	0.66
Open Bushland	515	1.3
Total Area	38,923	100

Source: Relief Society of Tigray (ReST)

The land-use pattern (*see* Fig. 1) shows that out of the total arable land in study area about 97 per cent is under crop cultivation while the remaining 3 per cent is covered by different types of bush and grass which is used for cattle grazing. The land-use, in the main, reflects strong influences of climate, soils, topography and demographic pressure on the land. In addition to this, the figures also reveal the fact that a significant portion of the slopes with some soil depth are under cultivation because of the shortages of arable land.

The intensively cultivated land covers a large portion of the study area. Particularly all the land is opened up for cropping and grazing livestock. Hardly any vegetation cover is seen in the arable land except in enclosures and some fallow areas of the previous cropping season. Almost about 80% of the land is under crop cultivation during the cropping season. The central zone of the Regional state of Tigray, far worse than other zones, is the most degraded part of the region where the two study woredas are not exceptional.

As elsewhere in central Tigray highlands, livestock is kept not only to provide milk, hides and skins, and drought-power and pack animals, but also to serve as a means of security against crop failure. An estimate made by the regional department of planning and economic development for the whole of central zone suggests that the livestock depends on the cultivated land for more than 30 per cent of its annual forage supply. In fact, about 60 per cent of the feed during the dry season is estimated to come from the cultivated fields, mainly in the form of cereal straws (DPED, 1993).

2.5 Land-Use Practice and Livelihood

For natural resources that are under the direct management and control of the farm family i.e., on-farm resources, the household economic model can provide some useful insights into the motives for conservation. It is known that the general production of the household model is that labor time is allocated to different activities up to the point where the return to the one more unit of time in an activity is equal to the opportunity value of labor, which is the market wage. Management of environmental resources brings a

complication to this prediction because it involves a stream of costs and returns evolving over future time, example, the decision whether to build a terrace to prevent soil erosion involves an interaction between the current opportunity cost of labor time and the expected future income gains from terracing (Ellis, 1993).

A considerable proportion of resource conservation by farm households occurs as an intrinsic feature of farming systems, and is not separable from routine farming practices in terms of costs and returns. In ordinary circumstances farmers do not farm in ways that cause their yields to decline in successive years (Netting, 1993). Nevertheless, increasing livelihood stress due to, for example, a severe downturn in the market price of the output of a cash crop, a labor short-age, or civil breakdown, may result in the neglect of routine conservation practices. The basic concept of *livelihood* is widely and frequently used in the contemporary poverty and rural development literature. Despite the existence of many definitions of *livelihood*, its meaning often appeared to be elusive. Chambers and Carney (1992 as cited by Frank Ellis, 2000, 7) for instance, defined *livelihood* as it ...“comprises the capabilities, assets (stores, resources) and activities required for a means of living.” But later on, seeking to give more embrative concept by bringing the claim and access issues, Frank Ellis (2000, 10) redefined *livelihood* in the following way: “A *livelihood* comprises the assets (natural, physical, human, financial and social capital) that together determine the living gained by an individual or household.” A *livelihood* is sustainable when it can cope with and recovers from stress and shocks, and maintains-or enhance its capabilities and assets both now and in the future while not undermining the natural source base.

According to Ellis and Edward (2004), *livelihood* approach to poverty reduction comprises the three main dimensions of *livelihood*: asset of rural poor (divided in five categories of capitals), the activities (on-farm and off-farm), and the mediating process (institutions, organizations and social relations) which influence access to those assets and the use to which they can be put and the strategies adopted by the rural poor for survival. Therefore, due to the fact that it considers the factors that mediate access and claims in addition to assets and activities, the current study has adopted the Ellis's (2000) definition of *livelihood*.

The above conceptual framework (*see* Fig 2) shows the various interacting variables and processes in a land-use change along with their roles to either positively or negatively affect livelihoods in a given setting. There are two causes of land-use/land-cover change: natural phenomenon and man-made (human patterns of land-use). The former includes natural catastrophes like climate change flooding, drought, salination, faulting, naturally poor soil fertility etc... The latter, which is also a major reason, includes intensive human activities like poor land-use practices, governments' and NGO's various interventions (programs, projects, packages), soil erosion, overgrazing, deforestation (fuel wood and charcoal production, construction materials etc), cropland expansion on slopes and shrub land etc... The causes of land-use/land-cover change, be them natural or man-made, have immediate consequences to follow. Such consequences in turn will positively or negatively affect livelihoods. Some of the positive effects may include agricultural production and productivity, food security, economic growth and harmony between human use of natural resources and the function of natural systems. On the other hand, declining agricultural production and productivity, food insecurity, weak economic performance, widespread poverty (especially rural poverty), conflict between human use of natural resources and the function of natural systems, high vulnerability to famine during drought, depleting natural resource etc... could be some of the negative effects which are directly linked to negative consequences of land-use change. Communities will then respond in return to their pattern of land-use, positively or negatively, depending on what kind of impact the land-use/land-cover change has brought on their livelihoods.

2.7 Socioeconomic and Institutional Factors

As discussed above, socioeconomic and institutional factors influence land degradation through their impacts on farmers' decisions regarding land use and land management practices, including plowing, fallow, use of manure and other sources of organic matter, fertilizer use, and adoption of soil and water conservation measures. A non-exhaustive list of such factors influencing these decisions includes population pressure, poverty, land tenure relationships, the nature of local markets, local institutions and organizations, and

farmers' perceptions and attitudes. We consider each of these below, in the context of the highlands of Tigrai.

2.8 Population Pressure

As discussed earlier, the population of Tigrai is growing rapidly and, although the average rural population density is only 33 persons per square km, the population density per unit of arable land is much higher (138 persons per square km). As a result, farm sizes are very small and the use of fallow is rapidly disappearing, causing problems of declining soil fertility and erosion. Population growth increases the demand for land and contributes to farming on steep and fragile soils, also leading to erosion problems. It increases demand for biomass as a source of fuel, leading to deforestation and increased burning of dung and crop residues, thus increasing the problems of erosion and nutrient depletion. Population growth increases demand for livestock products and therefore leads to increased livestock numbers, causing overgrazing and consumption of crop residues by animals.

The impact of livestock consumption of crop residues on soil nutrient depletion is offset to the extent that manure is recycled to the soil; however, burning of dung removes much of these potential soil nutrients.

Population pressure also can contribute to other socioeconomic problems, which themselves contribute to land degradation. Poverty may be worsened by population growth as a result of resource constraints and decreasing returns to capital and labor in agriculture (Pender, 1998). Land tenure may become more insecure and landholdings more fragmented as a result of population pressure, particularly if (as in the past in Tigrai) land is redistributed by the government to make room for new landholders. Local institutions and organizations for collective action may break down as a result of population pressure, particularly if population change is rapid and large migration is involved, thus undermining the stability and homogeneity of communities (Pender and Scherr, 1998; Baland and Plateau, 1996).

Not all of the impacts of population pressure are necessarily negative, however. By increasing the value of land relative to labor, population growth may induce farmers to make labor intensive investments in land improvement and soil management, such as constructing terraces, composting or mulching (Pender, 1998; Tiffen *et al.*, 1994). In Tigrai, we do see large investments in soil and water conservation taking place, although much of this is stimulated by government policies and development programs (more on this below). Population growth may also induce beneficial changes in markets and institutions or investments in infrastructure that would otherwise not occur (Ibid.). For example, population growth is commonly held to induce development of more privately-held property rights, which may favor investments in land improvement and better soil management, though this is much debated in the African context (Plateau, 1996). It may also induce development of infrastructure and markets, by allowing the fixed costs of these developments to be spread over a larger number of beneficiaries (Pender, 1998; Tiffen *et al.*, 1994; Boserup, 1965).

2.9 Poverty

The extreme poverty existing in Tigrai likely contributes to land degradation for many reasons. Population pressure on the land is worsened because people lack access to alternative sources of livelihood. Deforestation and burning of dung and crop residues are increased by people's inability to afford or lack of access to alternative fuel sources. Poverty similarly limits farmers' ability to purchase feed or livestock products, contributing to overgrazing, and their ability to purchase chemical fertilizer, contributing to soil nutrient depletion. Poor farmers may lack access to draft animals, implements, or other capital items needed to make major investments in land improvements. Poverty tends to increase farmers' short-term perspective, limiting their interest in investing in soil and water conservation measures that yield benefits only in the longer term (Holden *et al.* 1998; Pender, 1996). The lack of education or access to information associated with poverty may cause farmers to be less aware of land degradation problems, or to attribute such problems to causes beyond their control, and thus may reduce their efforts to address such problems (Ervin and Ervin, 1982).

As with population pressure, however, there are also reasons to believe that poor people may be more likely to conserve their land. Since they may "own" little else than the land they occupy, poor farmers may have more incentive than wealthy ones to manage what they have carefully. Furthermore, they may have few alternative investments available to them, so they may give high priority to investing in the land. Finally, the opportunity cost of poor farmers' labor time may be very low at certain times of the year, encouraging them to make labor intensive investments in land improvement and soil management.

All land in Ethiopia is owned by the state. Nevertheless, farmers in Tigray have permanent rights to use and bequeath land, and thus may develop a strong sense of land ownership. This is discussed in more detail in the next subsection.

2.10 Land Tenure

Several aspects of land tenure arrangements influence farmers' decisions with regard to land management, including tenure security, whether land is managed privately or communally, landholding size and fragmentation, the ability to mortgage land, and the ability to transfer land by sale, lease, or bequest. We consider each of these briefly.

Tenure security determines the extent to which farmers may benefit from investments made to improve the land. In the extreme case in which farmers expect to hold land for only the current season, they will have no incentive to invest; rather, their incentive is to get the maximum that they can from the land, even if that means undermining its future productive capacity. More generally, farmers may expect to use land for an undetermined period of time, but consider that there is some risk that they will lose this right in the future. The greater the risk of losing the right, the less likely they are to invest, or to conserve the productive capacity of the land (Feder, *et al.*, 1988).

It is important to recognize that tenure security does not require private land title, or even private ownership. There is substantial evidence from elsewhere in Africa that farmers can be secure in access to a given piece of land and make investments on it without having title, and even where land is communally owned (Otsuka, 1998; Platteau, 1996; Place and Hazell, 1993). What is required is recognition and respect of the right of an

individual or well-defined group to continue to use a given piece of land over a long enough term for investments to be viable. This may exist under communal or private tenure, and whether or not such rights are officially sanctioned by the state through titling or other means.

Communal tenure may undermine incentives to manage land in a sustainable manner for other reasons. Where land is managed collectively, "free rider" problems may undermine the incentive of individuals to contribute to successful collective action (Olson, 1965; Hardin, 1968). There is ample evidence that such problems can be successfully overcome in developing countries (Baland and Platteau, 1996; Ostrom, 1990), but the ability to do so may be undermined by many factors, such as instability of community membership (for example, as a result of migration), breakdown of social norms, short time horizons, a large group of beneficiaries, etc. (Rasmussen and Meinzen-Dick, 1995). On the other hand, communal tenure may allow community members to take into account the costs of one farmer's management decisions on other community members, or social or equity considerations that may not be adequately accounted for under private tenure (Platteau, 1996).

Small landholdings and land fragmentation may undermine farmers' interest in undertaking some types of land improvements, regardless of tenure security or private management. For example, farmers may find the costs of hauling manure or other organic materials to distant and small plots not worth the considerable effort required. In addition, investments that can be easily damaged by free ranging livestock or subject to theft (such as trees) are less likely to be made far from the household where it is difficult to protect them.

The ability to mortgage land may affect farmers' access to credit, which may in turn affect their ability to make land-improving investments (Feder *et al.*, 1988). Evidence from elsewhere in Africa suggests that this may not be a serious constraint where formal credit markets are not well developed and farmers rely primarily on their own savings or informal sources of credit (Place and Hazell, 1993; Gavian and Fafchamps, 1996).

Nevertheless, the absence of this option may limit the development of formal credit markets, particularly where commercial agriculture is developing.

The ability to transfer land can have several impacts on land management. Land sales and leasing allows land to be used by farmers who are able to earn the highest return from it, perhaps because of greater access to scarce factors of production (such as draft animals, farm implements, labor, or management ability) or greater interest or ability to invest in land improvement (Pender and Kerr, 1997; Besley, 1995). The ability to transfer land may provide greater incentive to invest in land improvement, since this increases the farmer's ability to recoup the value of such investments (in the case of sales or leasing) or extends the time period during which investments may yield meaningful benefits (in the case of bequests) (Pender and Kerr, 1997). In addition, mixed leasing arrangements such as sharecropping may increase farmers' access to scarce factors of production such as labor, credit, or draft power, or may help farmers to cope with risk in the context of imperfect information and contract enforcement (Braverman and Stiglitz, 1982). These effects may in turn influence whether farmers are able to manage land in a sustainable fashion.

The systems of land tenure that have developed in Tigray have had various impacts on these tenure characteristics and thus on land management. Prior to the fall of Haile Selassie in 1974, there were three dominant tenure systems in Ethiopia, *Risti*, *Gulti*, and church land. The *Risti* system was prevalent in most parts of Tigray. Under this system an individual had usufruct rights to land (*Risti* rights) in a given community if he/she was able to establish descent from someone recognized as an original holder of land or the founder of the community (Bruce, 1976; Dessalegn, 1984). The individual's usufruct right to land could not be transferred to others through sale or mortgage, although he/she could lease them temporarily. The right to land did not imply a right to any specific parcel; and land redistributions were periodically undertaken to ensure that every member of the family was granted access. The principle of equal division governed land redistribution, with land divided into sections according to quality and then allocated by lottery. This system led to land fragmentation and deterioration in the quality of land. Since a holder in this system (especially in *diessa*) was entitled to use the land for only a

open access resources, leading to overexploitation. Moreover, there was no formal policy defining ownership or use rights of trees that grow on cultivated land.

In an attempt to promote equity of tenure, redistribution of plots within a short period of duration (in some cases as short as 1–2 years) was a common practice under the Derg (Dessalegn, 1984). This led to diminution of plot sizes, disruption of production activity, and increased tenure insecurity, rather than solving it (Ibid.). In this context, lack of secure tenure was not merely due to the absence of private ownership as such, but rather to the fact that existing social structures allowed those who controlled usufruct rights- in this case the government - to grant or withdraw these rights at will.

This feeling of insecurity was exacerbated by the military government's drive for collectivization. The government saw state farms and producers' cooperatives as the vehicle of development in agriculture. Hence, most resources for agriculture (including good quality land by evicting farmers) were directed towards this end. Forced villagization and resettlement also were pursued to promote collectivization, although these programs could not be implemented in most parts of Tigray due to the war. The consequences of the *Derg's* land and other policies included reduced agricultural production, conflict, famine, and increased land degradation and impoverishment, despite huge publicly-sponsored conservation efforts (Cohen and Isaksson, 1988; Kidane, 1991).

During the time of the *Derg*, the Tigray People's Liberation Front (TPLF) introduced important elements of land reform (Berhanu, 1998). The TPLF-pioneered land distribution also gave farmers usufruct rights to land, based on two principles: (1) a farmer needs to reside as a farmer in a given *tabia* to get land from the *tabia* and (2) land will be allocated to individuals, not to households, entitling every member of a household, both female and male.¹⁵

A *tabia* is the lowest administrative unit in Tigray, usually consisting of several villages. In most communities, land was redistributed until 1991 to accommodate young families and returnees from settlement areas. This resulted in further fragmentation of holdings. In 1995, more than three-fourths of respondents in SAERP's survey reported that land

fragmentation was a problem, in almost all cases because it caused plots to be too far apart to be able to look after them sufficiently (SAERP, 1997). In more than half of cases, the two most distant plots were more than one hour's walking time apart (Ibid.).

Since 1991, land redistributions have stopped in Tigrai, and the current land policy in Tigrai formally prohibits further land redistribution, except where public irrigation or other major infrastructure investments are being made, and allows land leasing for up to ten years. The impact of this policy is not yet known. Based on historical experience, however, it is plausible to expect it to reduce land degradation and promote farmers' investments in land improvement, to the extent that tenure security is enhanced and land fragmentation reduced by the policy.

CHAPTER III

3. RESEARCH METHOD AND MATERIALS

3.1 Research Approach and Design

The study uses both qualitative and quantitative approaches of data collection so as to enrich and clearly put the results of the study through their complimentary role. With the quantitative approach, the study seeks to examine the relationship between land- use change and its influence (positive or negative) on livelihood. The qualitative approach, on the other hand, will be used to explore stakeholders' (both woredas' agriculture and rural development offices, land-use administration departments, the local people, NGO's working in the study area and other similar relevant bodies) views and attitudes toward the issue under discussion which will be gathered through focus group discussion (FGD), unstructured interviews and open ended questionnaires. A descriptive cross-sectional study design is to be used to determine the implication of land-use dynamics on livelihoods.

3.2 Research Sampling

3.2.1 Sampling Area

The study is to be conducted in two neighboring woredas, namely Adwa Woreda and Laelai Maichew (Axum) Woreda, in Central Zone of the Regional State of Tigray. The two neighboring woredas are bordered by Mereb Leke woreda to the north, by Ahferom woreda to the east, by Naeder-Adet and Wera'e Leke woredas to the south and by Tahtai Maichew woreda to the west (*see* Map 2 and 13). The study area is selected mainly because land-use change studies carried out in the woredas are very limited, and very little or no issues have been discussed on the reports concerning the enormous impact land-use/land-cover change has on livelihoods. Furthermore, the author of this research study is very well aware about realities in the two neighboring woredas where massive rural development intervention efforts are going on by government agencies and local NGO's whose progress so far demanding investigations such as this thesis.

There are a total of 24 sub-woredas (*tabyas*) in both Adwa and La'elai Maichew woredas of which 19 are located within the former and the remaining 5 within the latter. A total

number of 125 households are drawn for the study where each sub-woreda's (*tabya*) share are 5 randomly selected households with even further proportional distribution to the next administrative village level next to the sub-woreda (locally known as *kushet*). The remaining 5 farm households are a reserve for possible drop outs.

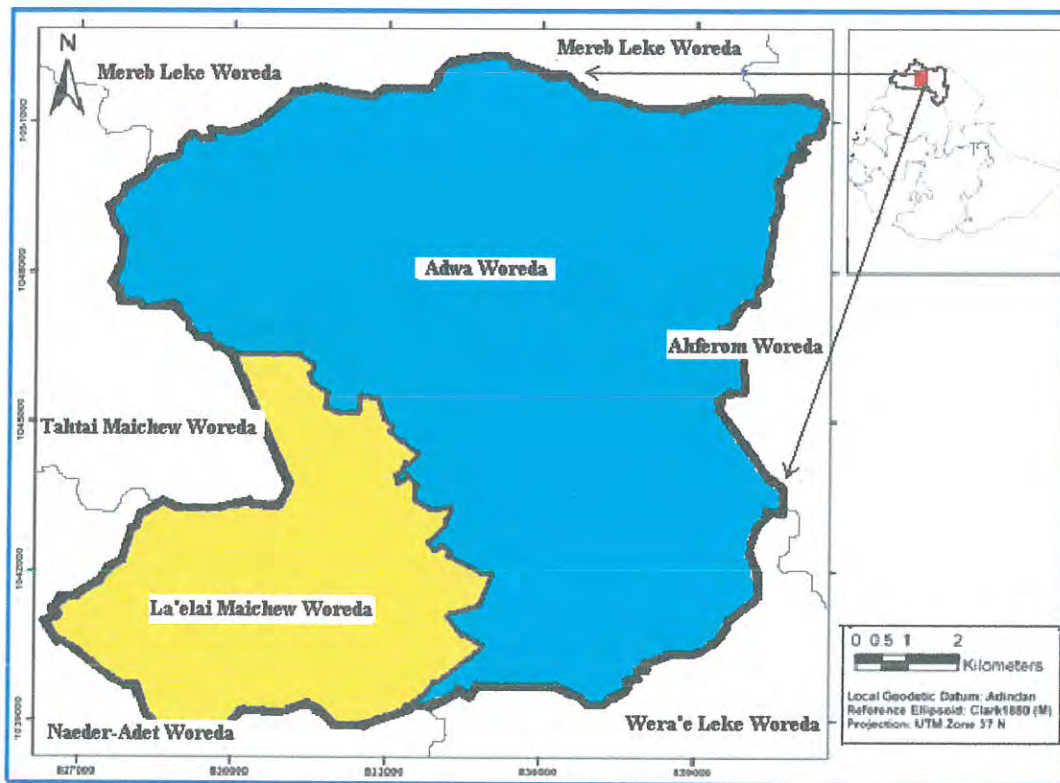
In addition to this, four (two for each woreda) focus group discussions will be held, each group comprising five to seven cultivated field owning elders and at least one rural development agent from the woredas' agriculture and rural development offices. In all, a total of 28 elder farmers and at least 2 development agents will be involved in discussions. In the course of verbal interactions unstructured questions are raised by the discussant (investigator of the research) only to guide and direct the responses to the main themes of the study, or else the discussions are led by the elder farmers themselves. Thus, discussion participants are encouraged to freely talk about their knowledge of soil erosions, crops, land-use change and its impact on their lives, interventions in the area and their results etc...



3.2.2 Sampling Households

The respondents from the randomly selected sampling households in the study area are all cultivated field owning farmers during the study period. Normally, the household head is the one to be approached for collecting data with full explanation of the objectives of the research and after only consent is received. The household could be male or female. In case, the household head is absent, the person temporarily in charge of the household is approached. The underlying premise behind the fact that all households in the study area are assumed homogenous is that their livelihoods have been and/or are equally treated with consequences of soil erosions, land degradation etc.. brought about by changes in land-use/land cover and ongoing government intervention in the in the study area.

Adwa and La'elai Maichew Woredas Location Map (Political)



Source: Ethiopian Mapping Agency (2007)

Map 2

3.3 Data Needed

Two major types of data are generated. Field survey collected from sample households from the two study area woredas includes mainly qualitative and quantitative aspects of data. The second type by which data is generated is analysis of panchromatic image. The former is concerned with collecting data on how livelihoods are affected as a result of change in land-use/cover while the later deals with the analysis of what exactly has been changed in land-use/cover.

3.4 Data Sources

There are two major data sources for this study. These are field survey and FGD (focus group discussion), and analysis of panchromatic aerial photographs of the study area. Well trained and carefully selected local high school students with rural area backgrounds have collected the required data from the farm households in the two woredas at every

have collected the required data from the farm households in the two woredas at every week ends for four consecutive weeks. Due consideration and priority is given to students' whose backgrounds are from the woredas from the local higher institution i.e. Axum University, to join the research personnel especially to assume supervising position for reasons of generating quality data if the time of their first semester break and the time of data collection overlap. The data collectors and their supervisors are trained for two days (one for each woreda's personnel) on basic data collection skills, such as on how to complete questionnaires fully translated into the local language in the study area i.e., Tigrinya (*see* Annex III), way of obtaining oral consent from respondents, interview techniques and other relevant precautions to data collection process. Data is also collected from potential key informants by FGDs which are conducted by the research investigator.

On the other hand, the required image data for the study was acquired from interpretation of 1:50,000 panchromatic aerial photographs taken in 1993/4 and 2007/8 obtained from the Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI), respectively, which are also used to create the spatial databases needed for the evaluation of land-use/cover change assessment. The establishment of the databases involved the following procedures;

- i) scanning the aerial photographs with 600 dots per inch scanner;
- ii) geo-referencing the photo mosaics according to the Universal Transverse Marketer (UTM) system using 1:50,000 topographic map of the area, and
- iii) delimiting and cutting out the study area by first racing it from 1:50,000 topographic maps and digitizing this separately in Arc View 3.1, and then superimposing the view on the spatial databases created from the photos.

The identification and classification of land cover types on the aerial photos required intensive use of mirror stereoscopes for visual verification because the photos were modified from a national satellite image obtained from MoWR. To avoid errors that would occur as details increase, the classification scheme was kept simple as follows:

forests, woodlands, shrub lands, open grazing lands, croplands and settlements, etc... Arc/Info version 3.5.1 was used to analyze the spatial databases created. Finally, two land cover maps were produced using Arc View 3.1, corresponding to the two years of reference, and temporal changes in the land cover were determined. Due to the absence of aerial photographs of a recent time (2009), maps could not be produced for the present day land-use/cover. It was also not possible to update the 2007/8 land-use/cover map through field surveys due to the time constraint. However, only little change would be expected between 2007/8 and the present time i.e., 2009.

3.5 Data Collection Technique

For reasons of time and budget constraints, and in order to have maximum precision as much as possible, a proportional simple random sampling technique is applied for the fact that there is a homogenous population in the study area.

3.6 Data Collection Tools

Collective questionnaires with both closed and open-ended, unstructured (in-depth) interviews, check list for FGD and field observations are to be used as research tools in both the quantitative and qualitative approaches by enumerators as well as during focus group discussion to generate data. All interviews will be provided with an interview guide.

3.7 Data Processing and Analysis

Survey data is analyzed with the help of SPSS software while image data is acquired from interpretation of 1:50,000 panchromatic aerial photographs which also is used to create the spatial database needed for the evaluation of land-use/cover change assessment. After the collection process of the field data is completed, each questionnaire is exhaustively checked for completeness and accuracy. Then it is summarized to reach at a certain conclusion using descriptive statistics supported by software statistical package.

CHAPTER IV

4. DATA ANALYSIS AND DISCUSSION

PART ONE

4.1 The Human Environment

A. Demographic Profile

Table 4.1 shows the demographic composition of the sample households. The total population of the 125 households was 326, of which 169 were males and 157 were females. The male population outnumbered the female population giving a sex ratio of 107.6%. The average household size was 5.1. But this average cannot be an indicator of the gross fertility levels of the population. The average household size refers to the number of individuals who were living under one roof; thus, it excluded children of some households who had established their own households. Nearly all the households were found to be nucleated families.

Table 4.1 Demographic Compositions of the Sample Households

Age group	Male	% of total	Female	% of total	Total (male + female)	% of total
0-14	33	49.7	28	49.7	162	49.7
15-64	31	45.0	27	48.4	152	46.6
≥65	5	5.3	1	1.9	12	3.7
Total	69	100.0	56	100.0	125	100.0

The overwhelming majority of the population was young. The population segment under the age of 15 years was around 50% of the total. The number of individuals whose age was above 64 was only twelve. The working age population, following the conventional categorization, was 152. The age-dependency ratio was 114.5%, which was composed of 106.6% young-age dependency ratio and 7.9% old-age dependency ratio. The fact that the majority of the population was young implies that the pressure on environmental resources is on the increase and that effective measures are required to control the problem. Viewing it from another angle, it may perhaps be stated that it is also a force that can be deployed for environmental rehabilitation and conservation works. Better environmental conditions were observed in some places with growth in population number (e.g., in a Kenyan district as reported by Tiffen, Mortimore and Gichucki, 1994).

B. Land holding

The distribution of farm sizes among the surveyed households is depicted in table 4.2. The average holding was 1.22 ha. Taking the average household size of the sample households, the per capita holding was 0.24 ha. There was a significant variation in the size of holdings among householders. Of the sampled households, the majority (56.2%) possessed between 0.6-1.0ha of land. Only 9.4% had more than 2ha and some 14.1% had ≤ 0.5 ha. The pattern is similar to the national level reality. According to CSA (1995), some 80% of the Ethiopian farmers in the highlands (>1500 m) cultivate less than 1 ha of farmland. Even worse, the number of households with small landholdings will increase with time owing to the increasing rural population and limited land resource. Resettlement of people from the densely populated and degraded highlands to the relatively sparsely populated lowlands may be a short-term alternative.

Table 4.2. Household size and landholdings of households

Total land held (ha)	% of total
≤ 0.5	14.1
0.6-1.0	56.2
1.1-1.5	9.4
1.6-2.0	10.9
>2.0	9.4

Nearly all of the interviewed farmers (93%) stated that agricultural lands were becoming scarcer in their communities. The decrease in landholdings was attributed to the increased population in the area (85.9% of the respondents). Only few (9.4%) mentioned land degradation and consequent abandonment as a reason, and still fewer (4.7%) reported that land was not scarce. The farmers were also asked whether their current holdings were adequate to support their families. About 48.4% responded that their holdings were insufficient. Still, the majority (66.1%) stated that they would not like to resettle elsewhere even if they were to be taken to new areas where land may be abundant.

The quality of farmlands varies considerably within *tabyas* and even within *kushets*. This is taken into consideration during land redistribution and readjustment activities. The result is that farmers operate more than one parcels of land, which can be located long

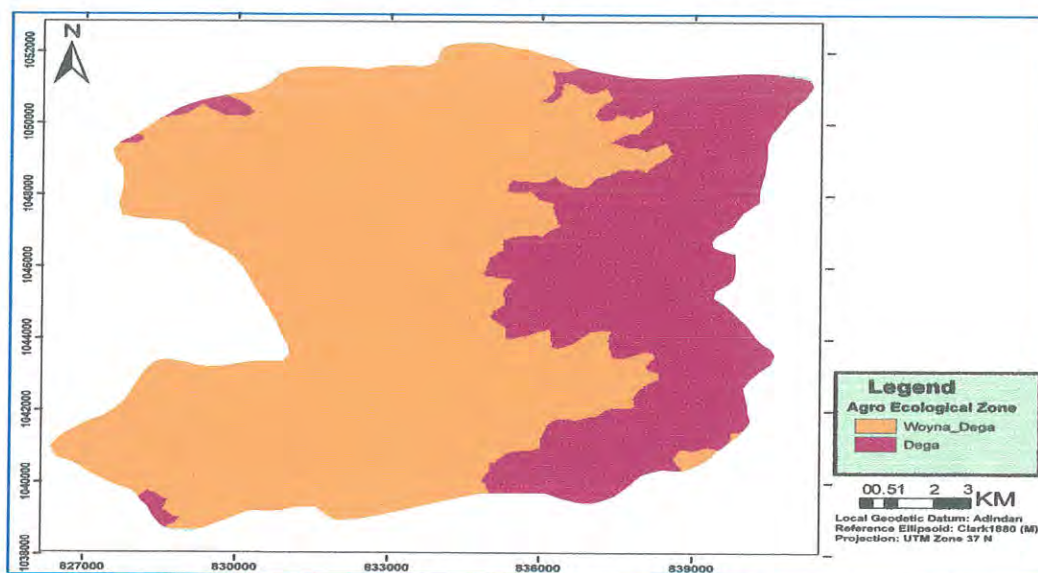
distances apart. The farmers included in the survey operated, on average, 3.53 plots. As it is often argued, fragmentation has negative side effects on the intensity with which land can be utilized and crops managed. For instance, fragmentation causes croplands to be reduced to narrow corridors running down slope. Such land strips will be inconvenient to apply structural soil and water conservation measures. Moreover, the “linear” shapes will dice ploughing to be carried out along the slope rather than across, which will significantly increase the magnitude of “tillage erosion”. Thus, these very small and fragmented holdings are, generally, conducive neither to optimization of agricultural practices nor to the application of land management measures. However, in view of the majority of the surveyed farmers, the advantages of fragmentation outweigh the disadvantages.

C. Crop Production

Crop production is the major source of income for the farmers in the study area. Barley (*Hordeum vulgare*), oats (*Avena sativa*), wheat (*Triticum vulgare*), taff (*Eragrostis teff*) and maize (*Zea mays*) are the important crops cultivated. All the crops are produced only once a year because of the unimodal rainfall distribution. Mixed cropping is virtually unknown to the farmers. The types of crops grown and the cultivation practices have important implications on soil erosion and land degradation processes.

Map 3

Agro-ecological Zone of the Study Area



Source: Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI)

Table 4.3 shows estimated incomes of the sample households from crop production at average *hagai* and *kiremti* season prices for the year 2007-2008. The produce is expressed in terms of monetary equivalents to enable comparisons and provide a universal yardstick for better understanding. The average price for the different crops varies between the seasons. Generally, it is low in the *hagai* season and high in the *kiremti* season, a few weeks after harvest. Barley and oats accounted for the largest share of the total annual income of households from crop production, followed by wheat and *taff*. Maize accounted only for a small proportion of the total household incomes. The farmers grow the different crops as a strategy to avert any risk, to spread out food availability and to adjust for local agroecological condition.

Nearly all the farmers (98.4%) stated that they had witnessed a decreased in productivity of their plots over the past 10 years. As reasons for the decline in productivity, “ageing of the land”, which must mean nutrient depletion, and the high price of chemical fertilizers were repeatedly mentioned (92.2%) of the respondents. Other reasons given by the framers included persistent drought, soil erosion particularly by landslide, and other more household-specific problems.

Table 4.3

Estimated average households’ incomes from crop production, 1993/4-2007/8

Crop type	Income (Eth. Birr)	% of total
Barley and oats	295.00	39.0
Wheat	217.85	28.8
<i>taff</i>	211.50	28.0
Maize	31.56	4.2
Total	755.91	100.0

Data Source: Study Area Woredas’ offices for Agriculture and Rural Development

D. Livestock tending

As in all other parts of the Ethiopian highlands, livestock are an integral part of the sedentary life of the people in the study area. Table 4.4 shows the number and types of farm animals kept by the surveyed households. The total number of farm animals of the surveyed households was 495, including cattle, sheep/goats and equines. This represents 7.73 farm animals per household. There were also 21 poultry, which is 0.33 per household. The composition of the farm animals was such that cattle accounted for

59.4%, sheep and goats for 31.7% and horses and donkeys for 8.9%. Oxen provide the draught power needed for the farming. Sheep and poultry are very important sources of cash and food. The contribution of livestock as cash sources of the farmers is significant. For instance, sales of livestock, livestock products, chicken and eggs contributed to 19.9% of the cash income of the surveyed households in 2008/09. Farmers usually sell farm animals to cover bigger expenses such as land taxes and other government obligations. The horses and donkeys transport people and goods.

As elsewhere in the country, livestock ownership is used as a measure of wealth of households in the communities studied. That is, livestock ownership is the main differentiating factor between the wealthier and poorer households as the farmers cannot be differentiated based on their land holdings about which they are insecure. Thus, there is a social standing attached to the number of livestock owned regardless of the feed shortage. There is a serious shortage of animal feed. In *kiremti*, the livestock are dependent on heavily degraded (overgrazed) communal lands and on some crop residues collected in *hagai*. In *hagai*, crop residues are the main feed. Residues of wheat, barley and oats are, however, also used as roof covers, thus sometimes an absolute choice to be made in whether to use the residues as animal feed or as part of own shelter. The shortage of feed is due to both decreased productivity of available grazing lands and shrinkage of the grazing lands due to encroachment by cultivation.

Table 4.4. Total Number of Livestock Owned

Livestock	Total number
Calves	55
Cows	88
Heifers	31
Horses	14
Oxen	69
Sheep	147
Goats	10
Donkeys	30
Yong bulls	24
Poultry	21

The causes for the shortage of livestock feed were drought, human population pressure and land degradation. Some farmers also stated that the common property nature of the

grazing lands contributed to its degradation and shrinkage in the area. On the other hand, the majority of the farmers expressed that they would not suggest distribution of the grazing lands amongst community members for a privatized use. As a lasting solution to the problem of feed shortage, the farmers suggested increased of grazing land areas, introduction of controlled grazing systems and reduction of livestock numbers. Regarding the trend in livestock numbers, it was learned from the farmers that there had been an overall increase at the village levels, while per capital holdings had been decreasing. The reasons for the decrease in the number of livestock per household include drought, feed shortage and inadequacy of veterinary services. The increase in the overall livestock population implies a growing pressure on the land resource base.

Oxen are the engines of the subsistence crop production activities in which the households are engaged. In deed, they constitute an important factor of production in many subsistence cultures elsewhere. In the Ethiopian highlands where cereal producing farmers perform their farming activities by ox power, lack of this main resource determines the vulnerability status of a household to food insecurity and famine. Oxen determine the efficiency of cropping. Thus, oxen ownership among the surveyed households in show separately in table 4.5.

Table 4.5 Number of Oxen owned per Household

No. of oxen	% of total
0	18.8
1	25.0
2	45.3
3	9.4
4	1.6

Nearly 19% of the households did not possess on ox; some 25% owned only a single ox; 45.3% had a pair of oxen; 9.4% had 3 oxen and only 1.6% had 4 oxen. At the national level as well, some 30% of highland farmers were found to be without an ox in 1993/94 (CSA, 1995). To have no ox or even have only one is a serious constraint on farming. The farmers without oxen try to overcome this problem and get their pieces of land ploughed through several arrangements. These include leasing out their lands for crop

sharing or for money, using ox pairing with others, exchanging human labor for oxen, pairing an ox with a horse and using a pair of horses.

E. Expenditures

Table 1.6 shows items of expenditure and amount of expenses which were incurred by the sample households in the year 2008/09. The largest item of expenditure was that for purchasing chemical fertilizers. Purchase of food items such as salt, edible oil, coffee, sugar, etc., which are not produced by households, constituted the second highest item of expenditure. Religious festivities, such as commemoration days of the Saints and *mahber* (a social/mutual aid association which involves festivities), constituted the third major item of expenditure.

The other important items of expenditure were for purchase of clothing, land use fees, purchase of kerosene, purchase of seeds, contribution for community works such as for the church, and expenses for the schooling of children. There were also wedding-related and death-related expenses. Since these were not recurrent items of expenditure, they were excluded from the analysis of the households' expenditure patterns.

Table 4.6 Items of Expenditure and Average Amount of Expenses (1993/4 - 2007/8)

Items of expenditure	Expense (Birr)	% of total
Clothing	91.61	14.7
Community contribution	15.33	2.5
Fertilizers	176.89	28.4
Food items	130.89	20.9
Kerosene	31.33	5.0
Land use fee	30.44	4.9
Religious festivities	110.00	17.7
Schooling children	12.73	2.0
Improved seeds	24.50	3.9
Total	622.99	100.0

Data Source: Study Area Woredas' offices for Agriculture and Rural Development

F. Income-expenditure balances

Annual income-expenditure balances of the sample households are given in table 4.7. Both the income and expenditure figures are as estimated by the farmers themselves. For the calculation of the annual incomes of the surveyed households, three activity

categories were identified: crop production, livestock rearing and sales of wood and wood products. No household was engaged in off-farm or non-farm works and also none had received any remittance. From all of these activities, annual incomes of the households were generally low and households were found to be highly vulnerable to seasonal food shortages. The average annual income from crop production was estimated at only Birr 755.91 on average (of *hagai* and *kiremti*) prices. Income from sales of livestock and livestock products including poultry was estimated at Birr 207.06. There would be a difference of about Birr 300, on average, in annual incomes from crop production comparing the *hagai* and *kiremti* prices, the higher being the *kiremti* prices. However, the farmers are required to pay land tax and other governmental and social obligations (e.g., religious festivities) in the *hagai* season; hence, they are deprived of the chance to exploit the raised market prices of the *kiremti* season.

Table 4.7 Income- Expenditure Balances, 1993/4 – 2007/8

Activity	Birr
Crop production*	755.90
Livestock raising including poultry	207.06
Sale of trees and wood products	75.70
Total income	1038.67
Total expenditure	622.99
Income-expenditure balance	415.68

* Data Source: Study Area Woredas' offices for Agriculture and Rural Development

No income was reported from an off-farm or non-farm activity and also from remittances. Hence, although land has become degraded and productivity has declined over time, it seems that the farmers lacked flexibility or the opportunity to move away from their age-old practices and engage in other income-generating activities. This indicates the need for an effective external intervention along this direction so that part of the population will be taken off the land. The other important (third largest) source of income was from sale of wood and wood products. This contributed to 7.3% of the total income of the surveyed households. About 50% of all the households covered by the survey responded that they generated some income by selling trees and/or fuel wood. Most of them sold trees planted by them, but a few others sold wood from natural woodland areas and forests, which may be rather a threat to the remaining meager nature vegetation cover in the watershed.

According to table 1.7, the net balance between total annual incomes and expenditures being positive might suggest that incomes were well above expenditures. However, the income-expenditure balances show the proportion of households' produce used for household consumption purposes; therefore, they don't indicate household level savings and capital formation. Because the households have no other sources of cash income, it is from sale of farm products that they meet their cash requirements to cover all their expenses. In addition, not all food produced is available for consumption as allotments should be set aside for seeds. Generally, the people of the study area, like those elsewhere in the country, are very poor and entirely dependent on nature. The use of chemical fertilizers is very low. Almost everyone heavily complains that the price of fertilizers is too high and prohibitive, contributing to growing food insecurity in their communities. Other modern agricultural inputs such as herbicides and pesticides are simply unknown to the farmers. The vulnerability of the households is such that, in any year, rainfall amount and temporal pattern determine the amount of food that would be available at the households' disposal. A shift in rainfall pattern of a cropping season easily translates into a period of food shortage. If shortage of rain extends for two consecutive cropping seasons, these subsistence farmers can become helpless victims of mass starvation.

4.2 Institutions

As indicated in the review literature part, the role that rural local organizations play in the livelihood of people is well documented. In the study area, among the number of roles that the institutions play in the social life of rural people, the following sharing arrangements have been identified in FGD as a means of access to draught animal and/or human labor.

Lifiniti: It is an agreement that is made between a person who has oxen but not labor and other person who has labor but not oxen and/or one with oxen and the other with out. The later ploughs the farm land of the former for two days and for him for one day.

Harestai-Riba'e: This is an agreement between two individual farmers, one with a certain amount of farm land and the other with out. The individual with out a farm land

then arranges an agreement to cultivate the land with its owner. The agreement may vary but usually the farm product is shared between the two individuals in such a way that one-third of the agricultural product is a share of the farmer with out a land while the remaining two-third of the total farm product goes to the owner of the land.

Metsamedti: This is an agreement that takes place between two farmers who have only one ox each. They use the draught animals turn by turn. This labor sharing arrangement in some parts of the country is known as *Mekenajo*.

Lawta: This method is used mostly by female household heads as they lack labor. Female heads may have oxen but not labor, so they give the oxen to a farmer who is able to use them and the person in return agrees to provide either labor to cultivate the land of the female household or provide certain quantity of farm product for use of the oxen. In any case, the two parties agree the use of the female head household's oxen in exchange for something. They state the quantity and date of submission of the product (in case of agricultural product) to be given for the oxen owner female household.

4.3 Demographic Dynamics and Changes in Livelihood Assets

The sustainability of the livelihood of rural people is based upon changes in the demographic characteristics of the households and the livelihood assets they have. The changes that had taken place in the study area in relation to the two during the five years are preserved below.

4.3.1 Demographic Dynamics

i) Age of Household Head

Table 4.8 shows the age distribution of households heads who were interviewed during the survey. Most of the household heads were found in the age group 40 – 49, while the percentage of respondents whose age was greater than 70 years was only 4.1%, which is the reflection of the narrow apex of population pyramid of the country. The mean age of respondents was 46.5 year.

Table 4.8 Distribution of Respondents by Age Group

Age Group	2006/07	
	Frequency	Percentage
< 29	33	8.5
30 – 39	67	17.2
40 – 49	115	29.5
50 -59	108	27.7
60 – 69	51	13.1
70 +	16	4.1
Mean	46.5	

Source: Field Survey, February 2009

ii) Family Size

One of the ways through which demography affects livelihood is through the size of household's which is closely related to production and consumption. The simple count of household members was converted into Adult Equivalent (AE) based on their age and sex distribution.

As can be seen from table 4.9, in 1993/94, for about 38.7% of households their family size was between 4.01-6.0. During the same year, only 1.5% the households had a family size of the greater than 8. The respective family sizes for the other 8.5%, 15.4% and 35.9% of the households were <2, 6.01 – 8, and 2, 01 – 4.

After five years (in 2008/09), the percentage of households with family size of less than 2 remained unchanged (8.5%). The percentage decreased for family size of 2.01 – 4 from 35.9% to 33.8%. The figure slightly increased for the remaining family groups. The mean family size was large in the mid-altitude area (*Enda Mariam Shewito, Mishilam tabyas*) (see table 4.9) and small in highland area (*Soloda, Gendebta, Enda Yesus tabyas*).

Table 4.9 Distribution of Households by Family Size

Family Size	1993/4		2007/8	
	Frequency	Percentage	Frequency	Percentage
<2	33	8.5	33	8.5
2 – 4	140	35.9	132	33.8
4 – 6	151	38.7	155	39.7
6 – 8	60	15.4	63	16.2
8 +	6	1.5	7	1.8
Total	390	100	390	100
Mean	4 (1.71)		5 (1.72)	
<i>t</i>	- 1.326 *			

Figures in parenthesis are in standard deviations

The average family size of the sample was 4 in 1993/4 and 5 in 2007/8 with insignificant change in respective standard deviations (1.71 and 1.72). The paired sample t-test shows that the change in mean household size between the two periods is not statistically significant ($p > 0.05$).

iii) Dependency Ratio

Dependency ratio refers to the ratio of the sum of total number of persons in the age group less than 14 and greater than 65 to the number of household members in the age group 15 to 64. It indicates the proportion of household members that are economically capable to contribute to livelihood improvement of a household. Table 4.10 shows that the percentage increased to 75.4 in 2007/8. The data also indicate the decrement of percentage of households with dependency ratio of greater than 1.1 from 42.6% to 24.6% during the five years. The average dependency ratio is large in the highland area (*Soloda, Gendebta, Enda Yesus tabyas* - which was 0.98) and the smallest in the mid-altitude area (*Enda Mariam Shewito, Mishilam tabyas* - which was 0.56).

(*Soloda, Gendehta, Enda Yesus tabyas* - which was 0.98) and the smallest in the mid-altitude area (*Enda Mariam Shewito, Mishilam tabyas* - which was 0.56).

Table 4.10 Distribution of Households by Dependency Ratio

Family Size	1993/4		2007/8	
	Frequency	Percentage	Frequency	Percentage
0 - 1	224	57.4	294	75.4
1 -2	107	27.4	82	21.1
2 -3	44	11.3	12	3.1
3 +	15	3.8	2	0.5
Total	390	100	390	100
Mean	1.21 (1.71)		0.79 (0.75)	
<i>t</i>	8.827 *			

Figures in parenthesis are in standard deviations

* Significant at 1%

Source: Field Survey February 2009

The average dependency ratio of the households was 1.21 in 1993/4 and the standard deviation was 1.05. In 2007/8 the mean dependency ratio decreased to 0.79 with corresponding decline in standard deviation to 0.75 in which the decrement of the ratio of economically unproductive to productive members of the household was statistically significant ($P < 0.01$). This decrement in dependency ratio can be attributable to insignificant change in family size of the sample.

4.3.2 Changes in Livelihood Assets

i) Natural Capital

From the different natural resources on which the livelihoods of rural households depend, this study considered land. The pattern of distribution of size of land holding is given in table 4.11.

Table 4.11 Distribution of Households by Size of Land Owned

Land Size	1993/4		2007/8	
	Frequency	Percentage	Frequency	Percentage
0 - 1	224	57.4	294	75.4
1 -2	107	27.4	82	28.1
2 -3	44	11.3	12	13.1
3 +	15	3.8	2	0.5
Total	390	100	390	100
Mean	1.21 (1.71%)		0.79 (0.75%)	
<i>t</i>	8.827 *			

(Source: Field Survey February, 2009)

As shown in table 4.11, about 57.4% of the households owned land size of less than 1 ha in 1993/4, while the size was between 2 and 3 ha for 11.3% of the households and those with 2-3 was 11.3%. The percentage of households which had size of greater than 3 ha was only 3.8% in the same year. In 2007/8, the percentage of households which owned a land size of less than 1 ha increased to 75.4%. The respective percentage of households with land size of 1-2 ha was 28.1%.

Except for land sizes of greater than 3ha (0.5%), for which the percentage of the households owning the respective sizes has decreased, the percentage increased for the remaining land size categories. The addition of another newly established households with no or small piece of land could be the reason for the increment of the former. The increment of households with land sizes of greater than 3 ha could be due to expansion of farm land into forest, grazing area and step slope areas.

Figures in parenthesis are in standard deviations

* Significant at 1%

The average land holding size in 1993/4 was 1.21 ha with standard deviation of 0.82 while the figure decreased to 1.06 ha after five years with increased standard deviation (0.84). However, the decline in mean land holding (mean difference) is not statistically significant as indicated by the paired sample t-test statistic ($P > 0.05$). Households in the low land area have relatively large size of land holding (1.98), while the mean size is 0.94 ha and 0.94 ha and 0.83 ha in the mid – latitude (Example: *Enda Mariam Shewito, Mishilam tabyas*) and high land areas (Example: *Soloda, Gendebta, Enda Yesus tabyas*), respectively.

Although the statistical test shows insignificant change in mean size of land holding, about 74% of the respondents replied that the size of land holding per household in the study area is decreasing. For the other 20.55 and 6% of the respondents, the trend is unchanged and increasing, respectively. Among the respondents who observed the declining trend of land holding, 55.6% of them attributed it to population growth. Regarding the sufficiency of their land, 65.1%, 17.2% and 3.6% of the respondents consider the size of their land in 1993/94 as small, sufficient, and excess, respectively. In 2008/09, the percentage of those households which consider their land as small increased to 67.7%. The percentage of household heads who consider their land size as sufficient and excess decreased to 15.6 and 2.8, respectively.

ii) Human Capital

Based on the conceptual framework, data on human capital were collected on educational level of household heads, labor force size, and health status of household members.

Educational Level: With regard to educational level of the heads, they are generally categorized in to literate and illiterate. The former refers to those respondents who can at least read and write. Among the sample respondents who can at least read and write. Among the respondents, more than half of the household heads (58.8%) were illiterate (unable to read and write). In the area, illiteracy rate decreased with decreasing altitude. That is, most literate households were from low land areas and were found to be few in number in the highland area.

Labor Force Size: In this study, labor force size of a household is described in man – equivalent which was calculated based on the age and sex distribution of household members. Table 4.12 shows distribution of households by their labor force. Nearly half of the households (47.4%) had labor force size less than 2, and 6 households (1.5%) and had greater than 6.1 in 1993/4. After five years, higher percentage of the households had labor force of 2.1 to 4. During the same time, only 7 households had labor force size of greater than 6. The average labor force size of the sample had increased by 18.8% from 2.56 in 1993/94 to 3.04 in 2007/8. The paired sample t-test also indicates statistically significant difference in mean labor force size of the households between the two years ($P<0.01$). The mean man equivalent labor force size was large in mid-latitude area and the size was small in the high land area.

Table 4.12 Distribution of Households by Labor Force Size

Labor Force Size	1993/4		2007/8	
	Frequency	Percentage	Frequency	Percentage
<2.0	185	47.4	122	31.3
2.1 - 4	150	38.4	172	44.1
4.1 -6	49	12.5	89	22.8
6.1 +	6	1.5	2	0.5
Total	390	100	390	100
Mean	1.21 (1.71)		0.79 (0.75)	
<i>t</i>	-9.474 *			

Source: Survey data, February, 2009

Health Status: The household heads were asked to evaluate the changes that s/he has observed concerning the health situation of the family members during the time of survey in relation to the condition before five years. 78.7% of the respondents avowed that the health status of their family member was well while the remaining heads reported health problem of their household members. For 69.9% of the heads reported health problem of their household members, the reason for poor health was high cost of treatment. Distance to health center is the other reason stated by the remaining households.

iii) Physical Capital

Variables that were considered as physical capitals are ownership of farm equipments, size of livestock owned, distance from market center, and distance from all-weather and/or dry weather road. As for other variables, distances from market place and main road were asked for two periods of time. Since the distance from the two has not changed between the two years, the data for 2007/8 was used for analysis. This is because the road was constructed before five years and no new market center was established in the study *tabyas* during the last five years.

Farm Equipments: The respondents were asked whether they had farm equipments such as plough, woke sickle, hoe, draught animals etc. The respective percentages of households who had all equipments, some equipment, and no equipment before five years were 33.6, 26.2 and 40.3. After five years those which had all farm equipments has increased to 36.9% whereas those which had no equipment decreased to 37.9%.

Table 4.13 Ownership of Farm Resource Equipments of Households

Farm Equipments	1993/4		2007/8	
	Frequency	Percentage	Frequency	Percentage
<2.0	131	33.6	144	36.9
2.1 - 4	102	26.2	98	25.1
4.1 -6	157	40.3	148	37.9
Total	390	100	390	100

Source: Survey data, February, 2009.

Household heads who stated that they did not have farm equipments include those who have no farm land, and those that have farm land but not draught animals. Those who have land but not oxen entered into share cropping arrangements to plough their land. Households which do not have farm land depend on off-farm and non-farm activities.

Livestock Ownership: The size of livestock that a household owns is given in Tropical Livestock Unit (TLU). The average number of TLU that households owned in 1993/4 was 2.55 with standard deviation of 2.65, which increased to 2.95 with decreased standard deviation of 2.63 in 2006/07. The paired sample t-test shows statistically

significant difference in the mean TLU that households own ($P<0.01$). As one can see from table 5.10, half of the households (50.5%) covered in the survey had less than 2 TLU in 1993/94 while the figure decreased to 44.1 % after five years. The percentage of households with TLU of 2.1 to 4 decreased between the five years gap. 22 % of the households did not have livestock during the time of survey. More than half (52.3 %) affirmed lack of income to buy breeding animals as a reason for not having livestock. The other reason mentioned by 24.4% of the household heads was lack of grazing land. Livestock disease was the third reason stated by 21 % of the heads. Similar to land holding, households in the low land area have relatively large size of tropical livestock units (3.2). The mean livestock sizes are 2.96 and 2.84 in the mid-altitude and high land areas, respectively.

Table 4.14 Distribution of Households by Livestock Ownership

TLU	The First 10 Years (1993-2003)		The last 5 Years (since 2003)	
	Frequency	Percentage	Frequency	Percentage
<2.0	197	50.5	172	44.1
2.1 - 4	108	27.7	103	26.4
4.1 -6	55	14.1	65	16.7
6.1 +	30	7.7	50	12.8
Total	390	100	390	100
Mean	2.55 (2.65)		2.95 (2.63)	
t	- 5.142*			

Source: Survey data, February, 2009.

iv) Financial Capital

Data on financial capital of the households were collected with regard to whether they received credit, remittance, and saved in cash or kind. In this study, access refers to whether the household heads received credit and remittance.

Access to Credit: The largest percentage of the respondents didn't receive credit during both periods (84.6% in 1993/4 and 81.35 in 2007/8). With respect to those who have received credit, the change between the two periods was also insignificant as only 13

household heads who did not borrow in 1993/94 borrowed after five years. The figures generally show limited access of households to credit services.

Table 4.15 Distribution of Respondents by Financial Capital

Finan. Capital	Credit Access	The First 10 Years (1993-2003)		Last 5 Months (since 2003)	
		Freq	%age	Freq	% age
Received Credit	Yes	60	15.4	73	18.7
	No	330	84.6	317	81.3
Saved Birr (Grain)	Yes	213	54.6	224	57.4
	No	177	45.4	166	42.6
Received Remittance	Yes	11	2.8	10	2.6
	No	379	97.2	380	97.4

Source: Field Survey February, 2009.

Savings: The heads were asked whether they saved in cash or kind to use in the case of emergency. As shown in table 5.13, 54.6% of the respondents stated that they saved in cash or kind in 1993/4. The number of households that saved birr or grain has increased to 57.4% after five years. Those which didn't save decreased from 45.4% to 42.6% between the five years interval.

Remittance: The percentage of households that received remittance was insignificant during both periods. The figure was 2.8% in 1993/4 and 2.6% in 2007/8.

v) Social Capital

Data on social capital was collected by asking heads of households of their membership in local Community Based Organization (CBO's) and their level of decision making in those CBO's in which they are members. The local CBO's considered were *Mahiber*, *Iqub* and *Idir*.

Membership in CBO's: Of the 390 households surveyed in the study, 349 of them (89.5%) said that they were members in at least one local community based organizations. Only 10.5% responded that they were not members.

Index of Decision Making in CBO's: The household heads were asked to subjectively evaluate whether their level of decision making in those CBO's in which number of their members is high, medium or low. Their responses were respectively scaled as 2, 1 and 0. Finally, it was averaged to get a single index. The value of the index ranges from 0 to 1.

The value of 0 shows that the head does not participate in decision making, and the value of 1 shows maximum involvement in decision making.

Table 4.16 Distribution of Respondents by Decision Making

Decision Making Index	Frequency	Percentage
0.0 - 20	74	19.0
0.21 – 0. 40	115	29.5
0.41 – 0. 60	159	40.8
0.61 – 0.80	41	10.5
0.81 +	1	0.3
Total	390	100

Source: Field Survey February, 2009

As can be seen from table 4.16, for larger percentage of the respondents (40.8%), their decision making index was between 0.41 and 0.60. For nearly half of the respondents (48.5%), their index of decision making was less than 0.40. The index was found to be greater than 0.81 only for one respondent.

4.4 Correlates of Sustainable Rural Livelihoods

Households employ different strategies to achieve certain desired livelihood outcomes. The outcome is derived from the assets that are found at disposal. Thus, the sustainability of the livelihood outcomes of households depends on the changing pattern of their demographic patterns and livelihood assets. This sub topic examines the role of household level demographic dynamics and changes in livelihood assets in achieving sustainable livelihood.

1. Livelihoods Sustainability Matrix

The study gives emphasis to economic and environmental sustainability discussing its link with land-use/cover change along with its implication on livelihoods. The former was measured in per capita equivalent of a household. The minimum level of per capita income to identify households in terms of their economic sustainability was US\$ 0.45¹. This value was selected based on poverty line that the Ministry of Finance and Economic Development (MoFED, 2005) used to estimate percentage of population living below

poverty line. Thus, the livelihood of a household was at least US\$164.25². For both years (1993/4 and 2007/8). Land productivity of the two periods was used as a proxy variable for environmental sustainability in which its productivity for the latter period should be at least equal to that of its productivity before five years. The livelihood of households that fulfilled these two criteria was considered to be sustainable.

Table 4.17 Livelihoods Sustainability Matrix

Per Capita Income per year (US\$)		Land Productivity		
1993/94	2008/09	Decreased	Unchanged	Increased
<164.25	<164.25	# (47)	# (89)	# (48)
<164.25	<164.25	# (56)	# (19)	# (45)
>164.25	>164.25	# (19)	§ (10)	** (57)

Based on the sustainability matrix given above, only 67 households fulfilled the criteria of static and dynamic sustainability. That is the livelihood of only 17.2% of the households is found to be sustainable. About 47% of the sample households live below poverty line of US\$ 0.45 in 2008/09. For about 5% of them improved per capita had taken place at the expense of land productivity improvement. The chi square test of association between land productivity and per capita income was found to be significant ($P<0.01$) with χ^2 value of 76.061 and degree of freedom of 4. Using the test proportion of 0.07, the binomial test shows statistically significant difference between households with sustainable and unsustainable livelihood at 1% significance level.

2. The Bi – Variant Analysis

Chi square test was used to examine whether there exists association between the dependent variable and the set predictor variables. The dependent variable is sustainability which was assumed to be influenced by demographic dynamics and changes in livelihood assets. The results are summarized in the tables 5.33 and 5.34.

Figures in parentheses are number of households categorized under that cell
 ** shows dynamically sustainable livelihood
 # shows statistically unsustainable/desperate household
 § shows statistically sustainable livelihoods

2.1 *Demographic Dynamics and Sustainable Livelihoods*

Age of the household head is one of the demographic variables that were found to be related to livelihood sustainability. The respective percentages of households headed by persons in the age groups < 35, 36 – 54, and greater than 55 that achieved sustainable livelihood are 4.8, 23.6 and 14.3. This shows that the livelihood of households with middle-aged household heads was more sustainable than those headed by younger and older aged household heads. The chi-square test also indicates statistically significant association between the age group of household heads and livelihood sustainability ($PP < 0.01$).

With regard to sex of the head, the livelihood of male headed households was more sustainable than their female counter parts. Among 294 male headed households included in the sample, the livelihood of 22% of them was found to be sustainable; while the figure is 2.1% among 96 female headed households. From households with sustainable livelihood, 975 of them were headed by males. The association between sex of the head and livelihood sustainability is found to be significant at 5% level of significance.

As far as the relationship between livelihood sustainability and adult equivalent family size of a household is concerned, the percentage of households with sustainable livelihood was 23% for households with family size of less than 4.25 adults. Among households with family size of greater than 4.25, only the livelihood of 10.3% was sustainable. The Pearson chi-square test also shows statistically significant ($P < 0.01$) relationship between family size and livelihood sustainability.

The relationship between change in dependency ratio of households and sustainability of their livelihood was found to be statistically significant. For about 23.6% of households with sustainable livelihood, their dependency ratio, the livelihood of 92.8% was unsustainable. It indicates that livelihood unsustainability is over-represented among households with increased dependency ratio.

2.2 *Changes in Livelihood Assets*

Much has been said about the role of changes in livelihood assets in sustaining livelihood. Land, the crucial asset to rural people, plays significant role in their life. As noted in table 5.34 below, among the households with sustainable livelihoods, 67.2% of them had a land size of greater than 1 ha (mean land size of the sample). On the other hand, of the households with land size of less than 1 ha, the livelihood sustainability is statistically significant ($P < 0.05$). This indicates that, given limited modern agricultural input, small land size yields low production.

Literacy rate of the household head is one of the human capitals related to livelihood sustainability. In this regard, as shown in table 5.34, among the households which achieved sustainable livelihoods, 91 % of them were to be headed by literate persons. This difference of livelihood sustainability due to literacy status is confirmed by statistically significant chi-square test ($P < 0.01$). The result is consistent with findings of other studies that households headed by illiterate household heads have high incidence of poverty (Tsegazeab, 2003) and low level of participation in soil and water conservation activities (Chalachew, 2004). Health status of household members, the other kind of human capital, was significantly related to livelihood sustainability as 95% of the households which stated poor health status of their household members had not achieved sustainable livelihoods ($P < 0.01$). From the total number of households for which livelihood was sustainable, 94% of them have improved health status during the last fifteen years.

As far as rural livelihood is concerned, labor force size of a household is an indispensable asset. In this case, livelihood was found to be sustainable for 79% of households with increased size labor force. The relationship was, however, not statistically significant. This could be attributable to marginal return to labor productivity. If labor force has increased on a limited size of farm land, it causes a declining return to production. A study by Degefa (2005) in Ernessa and Gabri woredas of Oromia Zone in the Amhara Regional State showed that due to surplus labor supply there is prevalent problem of unemployment and underemployment. Similarly, a study by Tsegazeab (2003) in rural

North Shoa found worsening living standard with increasing labor force due to low productivity of labor. One of the key informants in FGDs conducted in the study area also replied that: *"We are spending the resources we have on education of our children. Let alone the illiterate, the educated younger themselves are returning back to rural area and claiming the small plots of lands we have...."* Thus, unless alternative sources of income in non-agricultural activities are available to use the surplus labor, its contribution to sustainable rural livelihoods is limited.

Regarding ownership of livestock and livelihood sustainability, statistically significant ($P<0.01$) association was found between the two. Of the total respondents, the size of livestock has increased for 34.5% of them; and the livelihood of 30.2% of them was sustainable. Generally, from those households with sustainable livelihoods, livestock ownership has increased for about 86.6% of them. Ownership of farm equipments was also significantly related to sustainability of livelihood ($P<0.01$). The livelihood of 36% of households which had all physical equipments was sustainable. On the other hand, among households who had no farm equipments during both times (37.7%), the livelihood of none was sustainable. So long as most rural people depend on traditional production mechanisms, the role of farm equipment ownership is unquestioned.

The association between financial capital and livelihood sustainability is also presented in table 4.15. Significant relationship was observed between access to credit and sustainability of livelihood ($P<0.01$) as about 65.6% of households with sustainable livelihoods have received credit at least in one of the years considered in the survey. With respect to saving, significant difference was observed between households that saved in cash or kind and those which didn't. Among 67 households with sustainable livelihoods, 97% of them stated that they had savings during both years. The relationship between remittance and sustainable livelihoods was found to be insignificant ($P>0.05$). This could be due to negligible contribution of remittance to the livelihood of the people. The result shows that only 2.8% of households have received remittance. Besides, if income from remittance is used only for survival rather than investment in livelihoods assets, it may not contribute to improvement of livelihood.

As to the social capital of the households, participation or membership in CBOs was insignificantly related to livelihood sustainability ($P>0.05$). On the other hand, there existed significant index of decision making and livelihood sustainability. Among household heads with high index of decision making (>0.50), the livelihood of 46% of them was sustainable. Similarly of the 67 households that achieved sustainable livelihoods, the index was >0.50 for 83.5% of them.

Among the households that achieved sustainable livelihoods, 44.8% of them live in the high land area while the remaining 37.3% and 17.9% live in the mid-altitude and low land areas of the study area, respectively. However, the chi-square test shows insignificant association between agro-ecological location and livelihood sustainability ($\chi^2=0.912$, $df=2$, $p=0.634$).

PART TWO

4.5 Land-Use/Cover Dynamics Analysis

A. Changes in Land- Use /Cover

Land cover maps of the two adjacent woredas for the two years of reference derived from interpretation of the remotely sensed images are depicted in Maps 4 and 5. For clarity, a brief definition of the various land use/cover types is presented as follows:

Description of the land use/cover classes identified in the study area	
Land cover category	Description
<i>Definition source: Social Science Research Report Series, # 29. AAU Press. Addis Ababa</i>	
(Woldeamlak Bewket)	
Forest	Areas covered with dense growth of trees that formed nearly closed canopies (70-100%). This category included plantation forests, mainly eucalyptus and junipers, mixed with regenerating “indigenous” species of trees and bushes.
Moderately disturbed forest land	Uncultivated land containing scattered natural trees and secondary undergrowth. It contains some isolated big local trees.
Woodland	Areas with spares trees mixed with short bushes, grasses and open areas; less dense than the forest.
Shrub lands	Areas covered with shrubs, bushes and small trees, with little useful wood, mixed with some grasses. Some riverine trees were also included in this category.
Cultivated lands	Areas used for crop cultivation, mainly annuals.
Grazing lands	Open grassy areas used for communal grazing, as well as bare land that has very little or no grass cover (exposed rocks) but with the same tone on the air photos.
Open water	Areas covered by water bodies like small lakes, water streams, ponds irrigation and other purpose (like drinking water) dams
Aquatic Vegetations	Any vegetation species of perennial water plants, found widespread in lakes, streams, river banks, inside water bodies, and coastal waters etc...

Built-up Areas

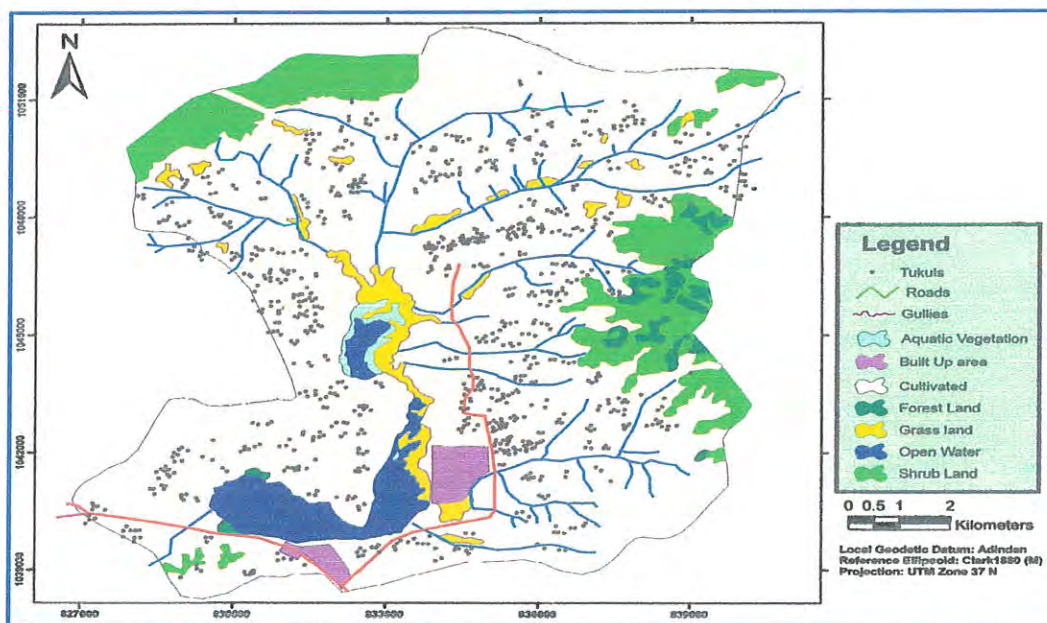
Various structures built for the purpose of SWCs, conserving natural resources, check soil erosion, develop water schemes, small irrigation etc.... by government and/or NGO rural intervention projects.

Settlements

Homesteads used for shelters/residence by people living in the study area; Eucalyptus, which are commonly found around homesteads, were also included in this category.

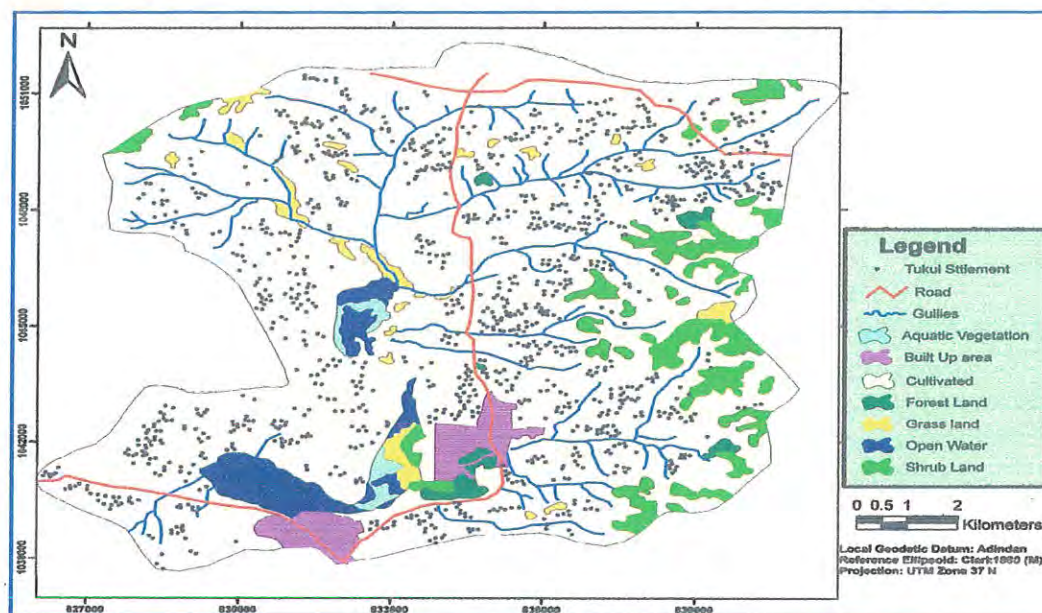
Map 4

1993/4 Land-Use/Cover Map of the Study Area



Map 5

2007/8 Land-Use/Cover Map of the Study Area



Source: Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI)

Scale 1:50,000

Change in Forest Land

Land cover under dense forest showed a considerable decline over the analysis period. And this matches with the sample household respondents' perception regarding forest land decline. In the study area, much of the forest cover was found on the steeper and upper slope positions of the landscape. In 1993/4, dense forest cover was 34% (1117.3 ha) of the area of the two woredas which was reduced to 4% (162.8 ha.) in 2007/8. Between 1993/4 and 2007/8, forest cover decreased by 64.4%. The average decrease was 32 ha. Per year, giving an average annual deforestation rate of 2.9%. This is an indicator of considerable transformation of forest land to other land cover categories. As a result, out of the 1993/4 forest land, about 72.5% (809.7% ha.) was changed to cultivated land and settlement, 8.5% (94.4 ha.) to bush and 6.1%(167.8 ha.) to degraded land categories. Thus, only 13.0% (145.4 ha.) of the 1993/4 forest land remained unchanged. This reveals that in the two neighbor woredas under discussion, forest removal for cultivation and settlement forms the major reason for its destruction. However, little transformation was made from other land covers to forest land category. As a result, only about 17.4 ha of

forest land was gained which, together with 145.4 ha retained from 1993/4, made a total of 162.8 ha in 2007/8.

Change in Moderately Disturbed Forest Land

The moderately disturbed forest land covered 14.1% (463.7 ha) in 1993/4, and was completely transformed to other land cover categories. The relatively high percentage of transformation to degraded land reveals that, in 1993/4, much of the moderately disturbed forest cover system was on the verge of destruction. The 45.1% transformation to cultivated and settlement land reconfirms the importance of clearing of uncultivated land for cultivation and settlement. It is also an indication of the little rehabilitation and reforestation attempts in recovering forests during the 15 years or so analysis period.

Table 4.18

Land-use/cover Dynamics between 1993/4 and 2007/8 in Adwa and Lae'lai Maichew Woredas in Tigray Regional State.

Land cover class	Year				% Change b/n 1993/4 and 2007/8
	1993/4 (ha)	(%)	2007/8 (ha)	(%)	
Forest land	1117.3	34	162.8	5.0	- 85.4
Moderately disturbed f.l	463.7	14.1	- - -	- - -	- 100
Bush land	118.7	3.6	177.9	5.4	+ 49.9
Degraded land	0.06	0.02	359.0	10.9	+ 99.84
Cultivated & settlement	1592.3	48.3	2592.3	78.7	+62.8
Total	3292.02	100	3292.02	100	- - -

Source: analysis of LU/LC raw data (panchromatic images) obtained from Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI)

Table 4.19

**Extent of Land Converted from Each Category to other Land Cover Category
between 1993/4 and 2007/8**

Change from	Changed to	Area in (ha)	(%)
Forest land	cultivated	809.7	72.5
	bush land	94.4	8.5
	degraded	67.8	6.1
	unchanged	145.4	13.01
Moderately disturbed Forest land	cultivated	209	45.1
	bush land	9.7	2.1
	degraded	239	51.5
	forest unchanged	6.2 0	1.3 0
Bush land	cultivated	73.4	61.8
	degraded	2.5	2.1
	forest	1.1	0.9
	unchanged	41.7	35.1
Cultivated and Settlement	bush land	32.2	2.0
	degraded	49.8	3.2
	forest	10.2	0.6
	unchanged	1500.2	94.2
Woodland	cultivated	209	43.2
	degraded	239	3.21
	forest	6.2	0
	unchanged	0	3.2
Shrub lands	cultivated	209	37.4
	degraded	239	24.1
	forest	6.2	0.3
	unchanged	0	3.21

Grazing lands	cultivated	209	17.1
	degraded	239	9.21
	forest	6.2	0
	unchanged	0	2.1

Source: analysis of LU/LC raw data (panchromatic images) obtained from Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI)

Change in Bush Land

As can be seen in table 4.18 above, the bush land category showed a slight increase from 3.6% (118.7 ha) in 1993/4 to 5.4% (177.9 ha) in 2007/9 in the study area. This reveals an increase in bush land category by 49.9% over the last 15 years analysis period. The increase is gained from forest, moderately disturbed forest and cultivated and settlement land cover categories. Much of the gain was from forest land suggesting an existence of forest quality degradation in the study area. Bush land also transformed to cultivated land settlement (61.8%), degraded land (2.1%), and forest (0.9%) land cover categories. Hence, the high percentages of transformation to cultivated land and settlement categories reconfirm that, in a subsistence agricultural society, clearance of uncultivated to cultivation and settlement represent the major reasons for land cover changes.

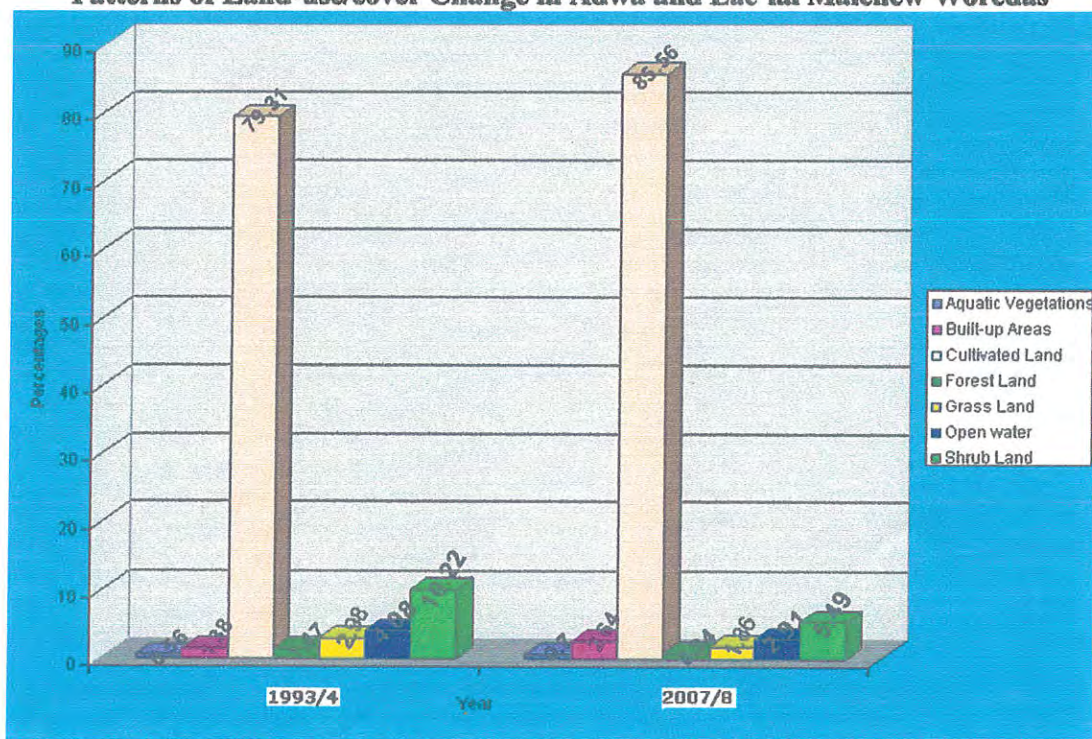
Change in Degraded Land

There was very little or almost no identified degraded land category in the year 1993/4 following the employed classification criteria. But, in the year 2007/8 aerial photographs, 10.95% (359.0 ha) of land of the study area was classified as degraded land category. This show 99.84% increase in the degraded land category from 1993/4 to 2007/8. This was mainly due to transformation of a part of other land cover categories (table 4.19). Transformation to degraded land occurred from forest (6.1%), moderately disturbed forest (51.5%), bush land (2.1%), and cultivated land and settlement land (3.2%) land-use/cover categories. The high percentage of transformation of moderately disturbed forest to degraded land may be an indication of its intensive exploitation by the local community for construction and firewood purposes, suggesting that these may be some of the other reasons in (forest) land degradation in the study area. It also implicates that

moderately disturbed forest category might have been at a critical stage of degradation in the period 1993/4 aerial photographs and probably an absence of rehabilitation activities (the civil war between TPLF and the *Derg* was at its peak in the two woredas, for example, in the years 1987 - 1990) in the study area caused its degradation. A gain from forest land is also an indicator of the existence of severe degradation of forest land within the analysis period. The existence of isolated trees in gullies of degraded land (table 4.19) means it was transformed from forest land via process of deforestation.

Figure 3

Patterns of Land-use/cover Change in Adwa and Lae'lai Maichew Woredas



Source: analysis of LU/LC raw data (panchromatic images) obtained from Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI)

Change in Cultivated and Settlement Land

Considerable expansion of cultivation and settlement land was observed from 1993/4 to 2007/8. During the analysis period, this land cover category contained the largest portion of the study area. It contained 48.3% (1592.3 ha) in the year 1993/4 and 78.7% (2592.3 ha) in the year 2007/8 of land of the study area. This showed a total increase for 62.8% between 1993/4 and 2007/8. The increase averaged to 33.3 ha/year, giving a rate of

expansion of 2.1% per year. Also, on the year 1993/4 aerial photograph, isolated big remnants of local trees existed in some cultivated plots, suggesting recent transformation of forest to cultivate and settlement land category of those land plots. This was verified in February 2009 during field observation. This expansion in field cultivation and settlement land probably suggests that, in the study area, food crop supply was achieved through farm land expansion rather than intensification. It may also implicate an existence of high population pressure with an increasing demand for arable, settlement and charcoal/fire wood resources. As discussed above, cultivated and settlement land encroached all non-cultivated land cover categories (table 4.18). This land cover category also showed a slight transformation to degraded land (3.2%), bush land (2.0%), and forest (0.6%) land cover categories. Thus, much of the transformation is to degraded land and the least is to forest land. This reconfirms that, in the study area, little effort has been made to rehabilitate the degraded land through reforestation for over a long period of time through reforestation programs. There fore, this study generally indicates a presence of a sequential change of forest to cultivated/settlement and, finally, to degraded land cover category.

In summary: -

1993/4: Most of the area was occupied by croplands (36%), followed by woodlands (28%) and open grazing lands (25%). Forest and shrub lands covered some 1.6 and 9.5% of the total area of the study area, respectively.

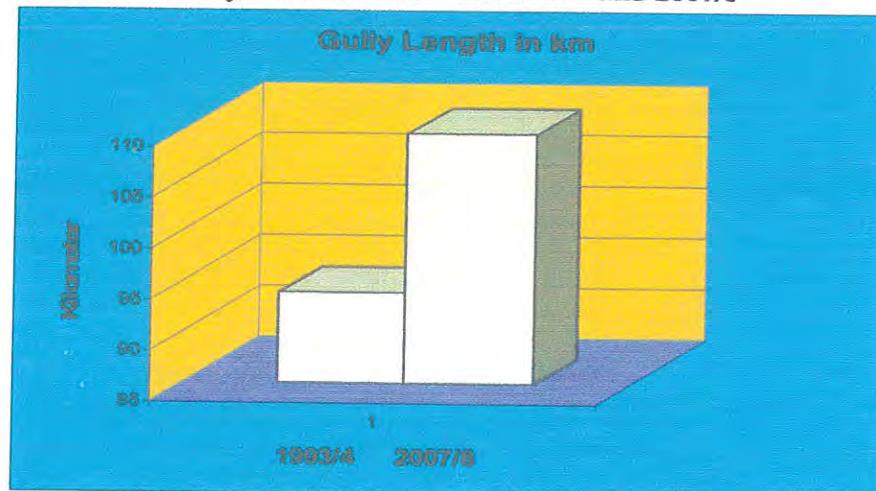
2007/8: The largest proportion of the two neighbor woredas remained under croplands by 2007 as well. But it had shown an increase, by more than 9.7 ha per annum between 1993/4 and 2007/8, to account for 65% of the total area of the two woredas by 1993/4. The increase of cropland area was corresponding to the growth in population numbers. Areas of forest lands, woodlands and open grazing lands showed a decrease over the same period. The decrease was very high for the forest lands and open grazing lands; it decreased from nearly 25% of the total area of the study area by 1993/4, and only 1.3% by 2007/8. This represents a rate of decrease of nearly 8 ha per annum. In addition to the growth of population, the decrease in the area of grazing lands was possibly due to the national level land reform of the 1975, which should have allocated a good part of the

grazing lands for lands for landless peasants. Human settlements emerged as a land cover type in the study area between 1993/4 and 2007/8, and accounted for 2.4% of the total area.

Table 4.20 Analysis of Land-use/cover changes in Adwa and Lae'lai Maichew Woredas between 1993/4 and 2007/8

Land-use/cover change	1993/4		2007/8	Percentage	Rate of Change
	Area(ha)	Percentage	Area (ha)		
Aquatic Vegetations	76.78	0.56	97.07	0.7	-4.32
Built-up Areas	190.29	1.38	363.58	2.64	+16.3
Cultivated Land	10942.70	79.31	11805.58	85.56	+ 80.9
Forest Land	13.5	1.62	14.2	1.70	+ 5.2
Grazing Land	410.12	2.98	257.88	1.86	- 94.7
Open water	563.62	4.08	402.47	2.91	-1.6
Shrub Land	1410.99	10.22	758.186	5.49	+ 60.0
Woodlands	234.7	28.11	118.6	14.21	-49.2
Settlements	-	-	20.0	2.39	+100.0
Total	71,330	100	71,330	100	-

Figure 4 Gully Structures between 1993/4 and 2007/8



Source: analysis of LU/LC analysis of raw data from MoWR and ILRI

Over the fifteen years considered, the major changes were the increase of the cropland and shrub land areas at the expense of the open grazing and woodland areas (see Maps 4 and 5). Unexpectedly, the forest cover showed an increase, but only very slightly. This increase is attributable to the massive reforestation and afforestation activities during the post *Derg* period and the planting of trees at the household level. As in many places throughout the country, there existed some afforestation undertakings by the community

during the *Derg* regime too. The little success achieved by this contributed to the increased area coverage of the forests. Much of the tree species planted by then local agricultural offices were junipers and eucalyptus varieties. The most important factor for the increased area coverage of forests is, however, the household level planting of trees, as a response to the growing scarcity of natural forests for various uses. At early 1990's, the entire forest area was under indigenous species; whereas by 2007/8, almost all the forest are of eucalyptus species.

B. Causes of Land-use /Cover Changes

Land cover changes are caused by number of driving forces spanning from natural to human (Meyer and Tuner II 1994). While impacts of the natural driving forces such as climatic change are felt only over a long time period, impacts of the human drivers are immediate and radical. Of the human factors, growth in population numbers is the most important under the Ethiopian setting (Hurni 1993) and generally in the underdeveloped countries (Hurni 1993; Mortimore 1993). For the study area, it was not possible to obtain consistent population figures for the last fifteen years because such socioeconomic data are organized along administrative levels which have been continuously structured. But the population growth rate to the national level shows that there has been an increasing population pressure on the land resource base. Along with the growth in human population, increase in the livestock population is to be expected. Hence, the growing human population had certainly been the most important factor to the observed land cover change through greater demands it imposes on land for cultivation and settlement and on trees for fuel and construction purpose.

Table 4.21 Factors Contributing to Land-use/cover changes

No	Factor for land-use/cover Change	Response (%)	
		Yes	No
1	Government policies/interventions	32.4	67.6
2	NGO/CBO intervention	2.8	97.2
3	Local peoples' attitude to the environment	66.5	33.5
4	Others (if any)	3	-

For the majority of the households (66.5%), the local peoples' attitude towards the environment is the major factor which is responsible for the ongoing land-use/cover

change. Other factors include government policies/interventions in different times (32.4%), non-government/civic based organizations' interventions (2.8%) and about 3% of respondents mentioned other additional factors respectively. This suggests that, people in the study areas are realizing that they themselves are the major causes of the negative consequences of land-use/cover dynamics (*see table 4.21*).

Table 4.22 Land-use/cover Changes Effect to Livelihoods

No	Land-use/cover Change's Effect	Response (%)	
		Yes	No
1	Positively	34.7	65.3
2	Negatively	78.2	21.8
3	Do not know	16	4
4	Others (if any)	6	0.2

The respondents were also asked about how the changes in land-use/cover they observed in their area have shaped the livelihoods. As can be observe from table 4.22 above, the majority 78.2% of them responded that the changes have negatively affected the livelihoods in their areas and themselves. For the other 34.7%, the story is different in that they said they have witnessed a positive change. These household heads are, in most cases, the ones who benefited from the community based natural resource management and/or the current government rural interventions. The remaining 16% respondents are not sure about the effects of the change.

Table 4.23 Land-use/cover Changes Effect to the Environment

No	Land-use/cover Change's Effect on Environment	Response	
		Yes	No
1	Positively	20.9	79.1
2	Negatively	83.7	16.3
3	Do not know	9	2
4	Others (if any)	3	1

With regard to the land-use/cover changes' effect to the environment, 83.7% of the respondents believed that it has negative effect, 20.9% believed the opposite while 9% of them are not sure what to say about it. These figures show that farming households in the study area are very well aware of the fact that changes in land-use/cover have adverse impact on the environment which in turn will affect the natural resource base their livelihoods depends.

4.6 Soil Erosion

A. Magnitude and Rate of Soil Loss by Riling

Table 4.24 below shows the total length and volume of rills in all of the surveyed fields. The total number of the rills was 34 with a total length of 861m. This figure represents rill density of 202.8m/ha. The total volume of all the rills was 98.5m³ (23.2m³/ha). This is equivalent to 25.52t/ha of soil loss given the soil bulk density of 1.1g/cm³. Because of the exclusion of the in Terrill erosion, the measured rill erosion rates underestimate the actual rate of soil loss. According to Gofers (1991), the contribution of in Terrill erosion can be more than 30% of the total soil loss in fields where rills are present. Assuming that the measured rill erosion rate underestimated soil loss by 30%, the actual soil loss rate was around 36.5t/ha.

Table 4.24 Total Length and Volume of the Rills in Damaged Areas

Rill parameter	Measured quantity
Length (m)	861.00
Volume (m ³)	98.50
Damaged area (m ²)	432.70
Damaged area out of total area (%)	1.02

Source: Adwa and La'elai Maichew woredas' offices for Agriculture and Rural Development (WoARD)

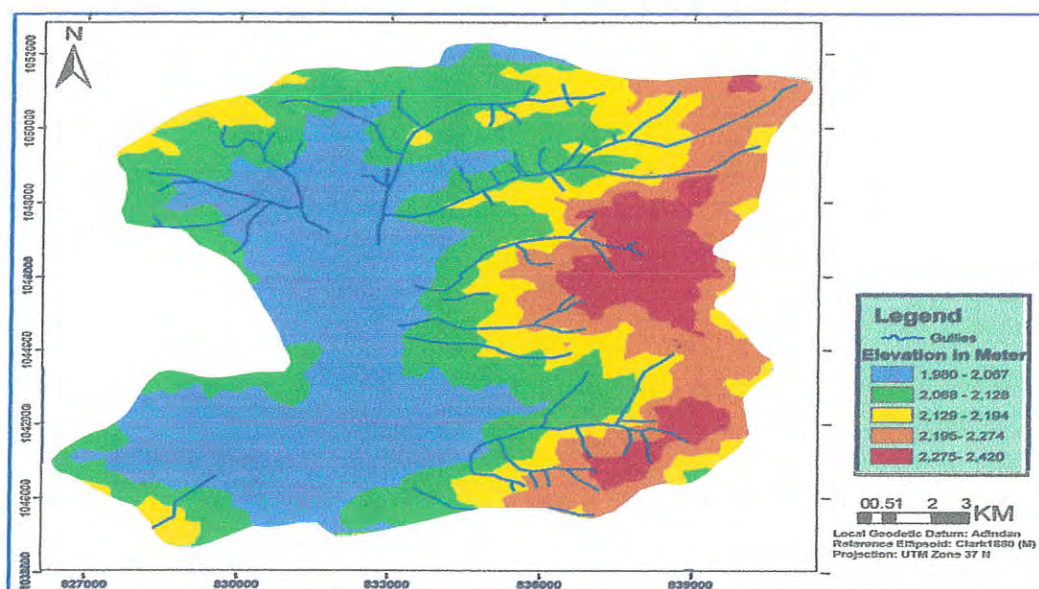
The total area of actual damage, the surface area covered by the rills themselves, was 432.7m² (Table 4.24). These areas show the direct impact of rill erosion on productivity of the cultivated fields via reduction of the total areas. However, the impact of rill erosion is much more than just a reduction in the area of productive land. Rill erosion is a result of surface runoff and associated sheet wash, which is process that selectively removes fine material and organic matter that are very important determinants of land productivity. On the other hand, the area of actual damage as a proposition of the total land area can give a clue as to the type of SWC that will be required. That is, the quantity of soil lost can be the same while the total area damaged is different, as in the case of several small rills and a single large gully. In the case of the former, soil and water conservation measures should be covering the whole field like mulching; whereas in the case of the latter, measures against the single gully will suffice.

Soil loss showed stronger and more significant correlation (at $P < 0.01$) with rill depths ($R^2 = 0.400$) than widths, which are having important implications on the soil and water conservation types that can be recommended. Depth was, hence, used to classify the rills into size categories. Accordingly, three classes of rills were identified: small (shallow) ($\leq 20\text{cm}$), medium (21-25cm) and large ($\geq 26\text{cm}$). Following this classification, 35% of the total rills were in the small and 50% in the medium size classes. The large rills were the least in number 15% of the total. Many of the small rills ended within individual fields and caused sedimentation problems. Though the sediments were left within field boundaries, fine materials and organic matter, which play vital roles in soil productivity, were obviously leaving fields suspended by surface runoff.

The medium rills contributed the largest share to the total soil loss, matching with the number of the rills. However, the contributions of the small and medium rills to the total soil loss and total area of actual damage were less than their proportionate contribution to the total number of the rills. On the other hand, the contribution of the large rills to total soil loss and area of actual damage by far exceeded their proportionate contribution to the total number of the rills. This reveals the existence of a positive and significant relationship between the depth and, width and length dimensions of the rills. Obviously, it is easier to control soil erosion by the fewer but larger-sized rills than the small but numerous rills as it will be requiring, say, construction of check dams and single grassed waterway.

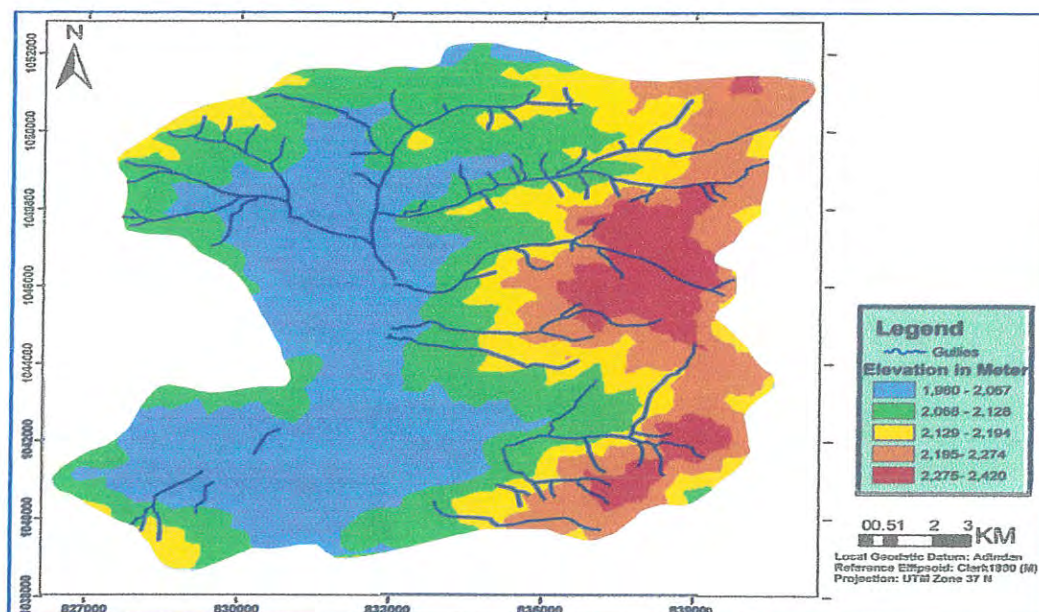
Map 6

Gullies with Elevation Map (1993/4)



Map 8

Gullies with Elevation Map (2007/8)



Source: Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI)

B. Processes and Immediate Causes of Rill Initiation and Development

Rill formation starts at the beginning of the rainy season. The beginning of the rains is the end of the long dry season over which all cultivated fields have stayed as communal grazing grounds and the soil has been exposed to the vigorous sun. This means that the soil is largely bare by that time, which increases its vulnerability to erosion. The monthly

distribution of the rainfall in the area as observed at the meteorological station of Adwa town as shown in Fig. 2. The rainfall is unimodal, extending from early February to end of September with a peak in August. It shows high concentration which has important implications on runoff generation, erosion and soil and water conservation measures.

Figure 3

Mean Monthly Temperature (T) and Precipitation for Adwa Metrological Station (2008)													
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
T (°C)	15	17	16	17	18	18	18	17	16	15	15	15	17
P (mm)	46	79	71	91	51	12	211	296	196	96	65	90	1304

Source: National Meteorological Service Agency (NMSA)

Both total amounts and few erosive storms were observed to be important in the process of rill erosion. Rills were initiated mostly by few destructive storms, but their continued growth throughout much of the wet season was the effect of the accumulative total rainfall. As was observed during the fieldwork, once they were initiated, most of the rills grew in length, depth and width throughout much of the wet season. This growth of the rills, while the land cover was and subsequent sedimentation by the cover itself. However, some of the rills, without sufficient protection to maintain their structures and sustain their flow, disappeared soon after their formation due to sedimentation. On the other hand, new rills continued to form throughout the wet season until the crops grew to heights that could effectively cover the ground surface and protected the soil. The formation of new rills in the later periods of the wet season was an effect of the higher antecedent moisture condition that contributed to generation of more runoff. So, the net effect was that maximum number and length of the rills will be attained towards the end of the wet season in almost every field.

As was observed in the field, the immediate causes of the rill formation and development could be classified into three categories: within-field concentration of runoff, runoff from upslope areas and breaking or overflowing of traditional ditches meant for soil conservation, locally known as *feses*. However, it was not possible to precisely determine the number of rills formed and/or the quantity of soil lost attributable to only one of the

three causes due to the interaction with one another. For instance, runoff from upslope was, in some of the cases, the cause for the destruction of the *feses* and subsequent formation of rills. Within field concentration of runoff caused formation of rills, and in some other cases, it was a cause for the destruction of the *feses*. Therefore, these three factors were interacting in complex ways, finally leading to a common consequence-loss of the soil.

In cases where the within-field concentration of runoff apparently the most important cause, the rills formed were small and ended within the fields themselves. Practically, these small rills simply translocated soil material within a single field, which will be redistributed by ploughing during the next agriculture season. Nonetheless, the within transfer of soil material also causes losses in land productivity by the erosion in a part of the field and by the deposition in another. Thus, it causes both the on-site and off-site costs of the process. The within-field concentration of runoff was accompanied by large volume of flow from upslope areas; all of the fields received runoff from fields in the upslope position. The sources of the runoff were cultivated fields.

The runoff generated within-field combined with the coming from upslope areas not only formed a network of rills, but also was a major cause for the overflowing or breaking of the *feses*, which in turn was observed to be a major cause of rill formation. The breaking or overflowing of the *feses* was basically a result of ill-designed dimensions, salutation and in-filling of the *feses* and total absence of maintenance of these structures after initial damages. The construction of the *feses* considers only land slope and not any other factors. Hence, breaking or overflowing of the *feses* was a rather common phenomenon after every high intensity storm. Once overflowing occurs along a *feses*, the energy released caused the destruction of many others in the downstream position. The salutation and in-filling of the *feses* was more common in lower ends of fields, where the runoff spreads out over a larger surface and forms a deposition fan (crop damage). The overflowing water was in turn a cause of damage in downstream fields.

4.7 Vulnerability Context

As discussed in the literature review part of this thesis, vulnerability context, is the external environment which is beyond the control of the households, includes trends, shocks, and seasonability. Although households can not overcome these problems at least in the short run, they use different strategies to minimize its impact on their livelihood. These elements of the external environment and the coping mechanisms of the household are explained below.

4.7.1 Trends, Shocks, and Seasonability

- i) **Trends:** In this study, the trends of population and resources in the study area are examined based on the data obtained from secondary sources, focus group discussions, and key informants.

Population Trend: Ethiopia as a country in general and the study area in particular is characterized by rapid population growth rate. To show this trend in the study area, the change in the size of population of the district was projected based on the growth rate calculated from the 1994 census data (CSA, 1996) and the 2005 statistical report of CSA (CSA, 2005).

Table 4.25 Estimated Population Size of the Study Area

Year	Population Size	Crude Density
1993	64521	85.4
1994	66044	87.1
1995	68162	89.9
1996	70348	92..8
1997	72603	95.8
1998	74932	98.8
1999	77334	102
2000	79814	105.3
2001	82374	108.7
2002	85015	112.1
2003	87742	115.7
2004	90555	119.4
2005	93459	123.3
2006	96745	128.2
2007	99687	132.9
2008	10340	137.5

Source: Computed by the author from CSA data

Population size, forest area and soil fertility are closely related. As pointed out in table 4.25, population size has increased by about 3.2 % per year during the given years. Crude population density, the ratio of total population to area of the district, also increased by about 36.2 persons per km² between 1993 and 2008 which means that crude density has increased by 3.3 persons per km² per year.

The respondents were also asked about the changes they observed in their area regarding to population size. As can be observe from table 4.27, 96.2 of them respond that population size is increasing. For the other 2.1%, 1.3%, and 0.5% of the respondents, the size is decreasing, remaining unchanging and unknown, respectively.

Table 4.26 Distributions of Respondents by their Perception about Changes in Population, Forest, and Soil Fertility (%)

	Increasing	Decreasing	Unchanged	Unknown
Population Size	96.2	2.1	1.3	0.5
Forest Area	2.3	95.6	1.8	0.3
Soil Fertility	1.5	85.1	5.9	7.4

Source: Field Survey February, 2009

This increment of population has implication on the natural resource base of the area. With growing population, given the natural resource based livelihood of the rural people, pressure on resources is expected to be high. That is, with high population growth, diminution of per capita land holding, absence of fallowing, land fragmentation, expansion of agricultural activity into fragile environment, etc... are expected with all its adverse consequences on the livelihood of the people and the environment. Such increased demographic pressure also leads to decreased agricultural labor productivity and increased food insecurity (Muluneh, 2003).

Resource Trend: The two types of resources that were included in the survey questionnaire to collect information on the perception of the respondents on the trend of change were forest cover and soil fertility. As shown in table 4.26, almost all of the respondents (95.6% and 85.1%) observed the declining trend of forest area and soil fertility. The remaining 2.3% and 1.8% stated that it is increasing and unchanged for forest cover change, respectively; while 1.5%, 5.9% stated soil fertility is increasing and remains unchanged, respectively. It was also observed during the field work that area

which was once covered with forests and is now changed into farm land. Almost all of the FGD participants attributed this trend of resources to rapidly growing population.

'Before some two to three decades one can arrive at forest areas after walking distance of few minutes. But now, due to population pressure almost all nearby forest areas were converted to farm land. Let alone forest area, we are lacking grazing lands for our livestock as people are cultivating those areas.'

The secondary data obtained from WoARD is also used to cross check with perception of the study participants. The data shows that the area of grazing land decreased by about 6.14% in one year from 9,842 ha in 1993/4 to 9,237.6 ha in 2007/8. An expert in WoARD also noted that forest that is found in the area is the one that is located at remotest area such as the source of Mereb River near Yeha highlands. Forests that are found in different pocket areas are almost totally cleared, according to this informant, due to expansion of agriculture.

- ii) **Shocks:** Shocks refer to sudden problems which negatively affect the livelihoods of the people. In order to identify the shocks that the households experienced during the fifteen years analysis period, FGD and key informant interviews were used. Accordingly, livestock disease was the most common problem raised by the discussants in the two agro-ecologies where the study was conducted. They stated that:

The farm land productivity has been declining to the extent that we cannot even fulfill our subsistence needs. To break this hardship of lives and improve our livelihood, we spend the limited resources we have on purchasing breeding animals. Unfortunately, the animals also died and/or at least, suffered livestock diseases.

A 61 year old man from the *Woina-Degu'a* traditional agro-ecology stated the sternness of the problem as follows:

I had borrowed money from Dedit Rural Micro Finance Institution (DRMFI) and purchased an ox. The ox died. Now, I am left with no draught animal. My land will be remained uncultivated unless I solicit oxen from other farmers or enter share cropping arrangements.

Trypanosomiasis is one of the highly prevalent livestock diseases in the area. The socio-economic profile of the district prepared by the Tigray State Regional Government (TSRG, 2005) also listed other types of animal diseases that are found in the area such as anthrax, blackleg, African horse sickness, pesterollosis, and internal and external parasites.

The other threat to the livelihood sustainability of the people is problem related to crop production. The FGD participants noted the adverse role that population growth plays in reducing crop productivity through absence of fallowing and farming of unproductive land. Moreover, crop pests such as termites, shoot fly, army worms, weevils, monkeys, apes and birds are common crop pests in the area (Ibid). Smut and rust are also crop diseases that cause crop failure.

Flooding, inadequate rain fall are also noted by discussants as a shock that affect crop production. For instance, data obtained from the WoARD show that 652.87 ha of land was affected by flooding in 1993/4. The frequent occurrence of torrential rainfall, particularly during summer time, was reported as a cause of severe soil erosion.

- iii) **Seasonality:** Climate is one of the important elements of the natural environment that positively or negatively affects the livelihood of people particularly those in rural areas. The spatio-temporal distribution of elements of climate determine cropping pattern, cropping calendar, type of livestock to be raised and so on (Degefa, 2005). Since agriculture in Ethiopia is rainfed, the pattern of distribution of rainfall has close relationship with the livelihood of the people. The importance of hydrology in Ethiopia is stated by the World Bank Group (WB, 2006: xi) as follows:

'Rainfall plays pivotal role in erosion, land degradation, reduced soil fertility and productivity, and siltation. Ethiopia's high intensity storms cause significant erosion. The erosive effective of rainfall are significantly augmented by Ethiopia's mountain, severe deforestation, and traditional agricultural practices of cultivating steep slopes without protective measures.'

The high dependence of rural people on rain-fed agriculture and limited irrigation practices worsen the vulnerability of the people to climate changes. In Ethiopia, there are cases where two extreme weather conditions affect the rural livelihood. Inadequate and unreliable rainfall causes the destruction of crops in the field, particularly in *kushets* adjacent to drought prone neighboring woredas like Mereb Leke woreda to the north, Wera'e Leke woreda to south east and Ahferom woreda to the east. On the other hand, high intensity rainfall aggravates soil erosion in the highland areas, due to lack of adequate conservation works. In this regard the study area is categorized under the second scenario of climate related problems. According to the participants of FGDs, torrential rainfall is responsible for the severe soil erosion.

The other problem related to seasonality and thereby rural livelihood is variation in the amount of rainfall that a given area receives throughout a year. There is high coefficient of variation during the months of November to February while the variation is not as such pronounced for the months of June, July and August. Such variation in monthly rainfall, given limited irrigation practices, is responsible for seasonality of farming activities.

Hydrological variability (extreme cases of flood and drought) is the problem of developing countries including Ethiopia, in which the poor are most sharply affected (WB, 2006). Rainfall variability trend of the study area is calculated from the total rainfall in year t as a percentage of the mean rainfall levels during 1993 – 2008. Accordingly, compared with the mean rainfall registered in the area during 1993 – 2008, rainfall variability has increased in the recent three years. Such fluctuation in rainfall (too little and too much rainfall) has significant implication on the livelihood of rural households. According to Kifle and Yoseph (1999), high variation in rains increases the food security risk to the average Ethiopian farming household. Its unreliability also increases the probability that farmers plant at a wrong time (Ibid).

Both too little and too much rainfall detrimentally affects the livelihood of rural people. Too little rain may cause crop failure and livestock death. On the other hand, coupled with rugged terrain and low conservation measures, is responsible for soil erosion. The

latter is found to be more prevalent in the study area. Even some informants stated that the problem of soil erosion is severe to the extent that they couldn't solve.

4.7.2 Coping Strategies

Coping strategies are one or a combination of mechanisms that households use to reduce the negative impacts of external environment explained in the preceding section. These strategies that households use to cope with shocks and stresses can generally be classified into two: asset disposal strategies and adaptive strategies. The former refers to the usage of livelihood assets that are accumulated during the ‘good times’ in the ‘bad days’. It includes selling of oxen, selling other livestock, and selling household properties. The latter shows the means of minimizing the impact of external environment by using mechanisms that are not related to asset disposal such as wage labor, borrowing money or grain, selling fuel wood and charcoal, and reducing meals.

Table 4.27 Coping Strategies Used by Households During the Last 15 Years.

Type of Strategies	The last 5 Years (since 2003)		The first 10 Years (1993 - 2003)	
	No of Responses	%age of Cases	No of Responses	%age of Cases
Selling oxen	86	22.1	92	23.6
Selling other livestock	139	35.6	130	33.3
Selling HH properties	96	24.6	98	25.1
Daily wage labor	285	73.1	262	67.2
Borrowing money or grain	165	42.3	159	40.8
Selling fuel wood or charcoal	123	31.5	136	34.9
Reducing meals	218	55.9	209	53.6
Others	5	1.3	7	1.8

Source: Computed from Field Survey February, 2009

As shown in table 4.27, engagement in daily wage labor is the coping strategy that was used by most households. Before five years, about 73.1 % of the households used this strategy. The second strategy that was used by most households during the same time was reducing meals (55.9%) followed by borrowing money or grain and selling of livestock other than oxen during bad times (42.3% and 35.6% respectively). During the last five years before the survey date, though the percentage of households which used wage labor decreased to 67.2%, it is still the widely used coping mechanism. Reducing of meals consumption and borrowing money or grain were the second and the third strategies used by 53.6% and 40.3% of the households, respectively. Generally, the sample households preferred adoptive coping strategies than asset disposal strategies.

When the two periods are compared as to whether there is a change in coping mechanism, no significant change is observed. However, there is a decrement of wage labor as a coping mechanism. This may be due to marginal return to labor productivity. With increased labor supply, the income to be obtained from wages is expected to decline which reduces its role as a strategy to overcome risks. On the other hand, the percentage of households which used selling of fuel wood and charcoal increases by about 10.6%. Most of the users of this strategy are those found in the highland area, where there is pocket of forest. From the point of view of environmental protection, it seems that the strategy depletes the existing forest of the study area.

4.8 Livelihood Strategies

As pointed out by Scoones (1998), this study explains the livelihood strategies of the sample by classifying them in to four: agricultural extensification, agricultural intensification, livelihood diversification, and migration.

1. Extensification: In the study area, the expansion of crop cultivation into marginal land was found to be significant for there were 16 household heads (4.1%) who reported that they expanded their farm land into other areas such as forests and steep slope areas. This may be because land with relatively high fertility and accessibility have been exhausted. The worrisome issue, however, is that households are converting grazing land that is at their disposal into cultivation. 54% of the household heads replied that they did not have

grazing land in 1993/4. After fifteen years, the percentage of such households increased to reach 60%. Similarly, the mean grazing land of households decreased from 0.13 ha in 1993/4 to 1.1 ha in 2007/8. This indicates that those households which have grazing land are converting it into farm land. The mean farm land of the respondents was 0.92 ha in 1993/4 which slightly increased to 0.93 ha after five years. Pender (2001) noted that expansion of farm land into forest and grass land is associated with little or no investment in land improvements (Pengali and Binswanger, 1987 cited in Tesfaye, 2003); it has negative impact on the livelihood sustainability of households. By and large, the decrement of grazing land may also contribute to dwindling of livestock population.

2. Intensification: The use of intensification as a livelihood strategy to achieve certain desired livelihood outcomes in the study area can be observed from lack of land to which cultivation can expand to and absence of fallowing. For Boserup (1965), absence and reduction in time of fallowing is the manifestation of agricultural intensification. In this regard, only 10.7% of the respondents stated that they fallowed their land before five years. The percentage of heads that used fallowing as a means of soil fertility decreased to 8% which indicates frequent cultivation of the available land.

According Tiffen *et al.* (1994), increase in labor input per unit of land shows agricultural intensification. In the study area, the mean land holding of the sample households was 1.07 in 1993/94 and 1.06 ha in 2008/09. On the other hand, man equivalent labor force size increased by 18.8% from 2.56 in 2.39 to 2.87% within fifteen years.

Intensification as a livelihood strategy yields non-declining product with the appropriate soil conservation and management mechanisms and the use of high yield increasing inputs such as fertilizers, pesticides, insecticides, improved crops etc... In this regard, the majority of the households (87.1%) used manure as a means of maintaining soil fertility. Mulching is the second widely used soil management mechanism in terms of number of households that used it. The figure shows low percentage of the users of modern inputs compared to the traditional mechanisms. During both years, less than 30% of the households used improved seeds, herbicide, and pesticides. Nearly more than half of the

households didn't use fertilizers to increase their farm land productivity. The respondents attributed limited use of fertilizer to its high cost. The farmers are also pessimistic with regard to taking fertilizers on loan due to fear of crop failure. Regarding the number of users of traditional and modern soil management mechanisms, no significant difference is observed except that the percentage of the users slightly decreased for all mechanisms other than manure application.

Table 4.28 Households' Use of Soil Management Mechanisms

Type	1993/4		2007/8	
	No of Responses	%age of Cases	No of Response	%age of Cases
Manure appln.	250	87.1	252	87.5
Mulching	224	78.0	223	77.4
Fertilizer	134	46.7	129	44.8
Improved seed	82	28.6	79	27.4
Herbicide	73	25.4	73	25.3
Pesticide	15	5.2	10	3.5

Source: Survey Data February, 2009

Table 4.29 Households' Soil Conservation Practices

Type	1993/4		2007/8	
	No of Responses	%age of Cases	No of Response	%age of Cases
Terracing	250	87.1	252	87.5
Planting trees	82	28.6	79	27.4
Check dams	73	25.4	73	25.3
Contour ploughing	15	5.2	10	3.5

Source: Survey Data February, 2009

Although agricultural intensification is considered as a positive process of increasing output, there may be negative effects on the sustainability of livelihood (Carswell, 1997). One of the consequences of agricultural intensification is environmental degradation (Turner et al., 1993 cited in Carswell, 1997). They stated that the long term sustainability of the agricultural resources base can be threatened by the process of intensification. In the study area, it was found that land productivity has increased for 38.5% of the respondents. For the other 30.3% and 31.3%, the productivity of land remained unchanged and decreased, respectively. Thus, agricultural intensification as a livelihood strategy is seen not only in terms of increased production per unit of fixed land but also in

its impact on the long term productivity of the natural resources, which is central concept of sustainable livelihood. In this regard the problem related to intensification is beyond of this study and requires further research.

3. Livelihood Diversification: One of the strategies that rural households use to achieve their desired livelihood outcomes is diversifying their activities. In the study area, households are engaged in different activities to diversify their sources of income. Among the sample respondents, 80% replied that members of their household were engaged in non-farm activities. The remaining 78 (20%) stated that no member of their family was engaged in activities other than farming and livestock rearing. The later households were asked why any member of their household was not engaged in non-farming activities. 34.6% of them stated lack of non-farm employment opportunity. The respective percentages of households which stated distance location of place of work and low payment for non-farm activities are 20.5 and 15.4. About 18% of the respondents said that they want to work only agricultural works. Regarding households that were engaged in some activities other than farming, the main reason (71% of the respondents) that forces them to be engaged in such activities is low agricultural product. This indicates necessity other than choice that derives livelihood diversification. 21% of the heads stated small or lack land as a cause of working non-farm activities. For the other 4.5%, 2.9%, and 1% of the respondents the respective reasons are seasonality of agricultural work, nearby location to urban center, and availability of non-farm employment opportunities.

Table 4.30 Livelihood Diversification Category

IHHD Category	Frequency	Percentage
1.00	36	9.2
1.01 – 2.00	253	64.9
2.01 -3.00	94	24.1
3.01 +	7	1.8
Total	390	390

Source: Survey Data February, 2009

As shown in table 4.30 above, there is perfect specialization for 36 households (9.2%). For the majority of the households (64.9%), the index is between 1.01 and 2.00. if there

were perfect diversification, the value of the index would be 6, indicating the income is equally distributed between the six types of activities. However, given the types of activities considered in the study, it was only for 1.8% of the households that the index is greater than half of perfect diversification. This suggests that, though most households (90.8%) are engaged in several activities, the income obtained from the activities is not evenly distributed between the six sources.

The difference in livelihood diversification for groups of the sample households is given in table 4.31. The mean index of livelihood diversification was found to be high for male headed households, households headed by persons in the age group 36 – 54, households with literate heads, households with land size of greater or equal to 1 ha, and households which live in the low lands.

Table 4.31 Differences in Mean Livelihood Diversification

Variable	Category	IHHD	
		Mean	Std. Dev.
HH Sex	Male	1.77	0.48
	Female	1.74	0.62
HH Age	< 35	1.77	0.52
	36 – 54	1.82	0.53
	55 +	1.63	0.48
Agro – ecology	<i>High land</i>	1.65	0.45
	<i>Middle altitude</i>	1.79	0.57
	<i>Low land</i>	1.97	0.49
Education	Literate	1.77	0.52
	Illiterate	1.75	0.52
Land size	< 1 ha	1.74	0.55
	> 1 ha	1.80	0.46

Source: Survey Data February, 2009

4. Migration: Migration is the other strategy that households can sustain livelihood. However, the role of migration in sustaining rural livelihood is insignificant in the study area. Among the respondents, only 2.1% stated that member of their family migrated to other area in 1993/4; and the percentage decreased to 1.8 in 2007/8.

4.9 Land Management Activities with Conventional Measures

Land management activities focusing on conventional measures were underway in Adwa and Lae'lai Maichew woredas beginning from January 1995. The two woredas' offices of the agricultural ministry were carrying out the work with financial support from USAID, Glimmer of Hope and Irish Aid along technical support from the local NGO ReST. It was a five-year resource management and development project where the study area was serving as a trial site for the Relief Society of Tigray (ReST) on-farm research program in Central Zone of the Tigray Regional State. The approach pursued was community based natural resource management type, where soil and water conservation was given a central place. The components of the project include Soil and Water Conservation (SWC), promotion of a forestation and agroforestry practices, crop production improvement through variety and agronomy trials and small-scale irrigation development, and forage and livestock development. Table 4.41 below shows the total cost (budget) of the project over the 5 years. The largest sum was for forage and livestock development (37.6%), followed by that for the establishment of a nursery (27.5%). The budget for the construction of the physical soil and water conservation (SWC) structures counted for 13.6%. But it can be said that it had also share in the establishment of the nursery because some of the Seedling production were to be planted on the physical soil and water conservation structures (agroforestry). The study focused on the SWC component of the project.

The trial site did not cover the whole area of the two neighbor woredas. It only covers a total area of 360ha as a trial site in both Adwa and Lae'lai Maichew woredas. This total land area was cultivated by a total of 205 households, who also had some additional plots of land elsewhere outside of the trial site's boundary. The total population accommodated by these households was 722, which was constituted of 354 males and 368 females. This gives an average household size of 3.5 members. The average land holding of the household using lands within the study area was 1.54ha.

About 65 % i.e., 81 out of 125 sample households (of which about 53 are from Adwa and the remaining 28 are from Lae'lai Maichew woreda) live in *tabyas* where the trial site is

located; possessed plots of land within the boundary of the trial site delimited for the trial as well as those outside were involved in the implementation of the conservation measures. Of the sample households, there were only 44 households who were exempted from the work. This group of people included clergymen, the elderly and female-headed households without working age children. As an incentive to the farmers whose plots were treated, spades and shovels had been given by the beginning of the project. Giving of these farm implements as indirect incentives was preferred to giving direct incentives, such as food-for-work payments, to increase the willing participation of the farmers by avoiding dependency mentality among the farmers.

As was learned from discussions with the farmers and development agents working in the site in the focus group discussions (FGD), the local people were initially opposed to the idea of the community based natural resource management intervention. Their resistance stemmed from the fear that the trial site was to be set aside for a community forestry development. Convincing them about the whole purpose of the program took a great deal of time and involved repeated meetings and thorough discussions. The final option was to take few influential farmers, who were selected by the local people themselves to one of the experimental site of the soil conservation and research project (SCRIP), near the town of Axum within Lae'lai Maichew woreda, to see outcomes of the community based natural resource management undertaking. Reportedly, after hearing from these influential farmers, the local people agreed to undertake the project activities. Thus, it is believed that the farmers' participation in the projects ensured the local peoples' rights from the very start and before the beginning of any actual work on the ground.

The task of facilitation in the implementation of the planned intervention works was a responsibility given to the development agents (DA's), whose wage was jointly paid by ReST and the Bureau of Agriculture and Rural development of the two woredas. A 'Development Committee' was formed and made available to assist the DA's, particularly concerning non-compliance and absenteeism during conservation working days. The 'Development Committee' together with the DA's ensured that each household came for the conservation work on the specified dates and times. If a household failed to come for the work for non-serious reasons, he/she would be fined Eth. Birr 3.00 for each

day of absenteeism. But if one could present a valid reason, he/she was simply made to do the work in another day. The strictness with the agreed-up-on days was simply men tot make sure that each household accomplished its share of the conservation structures. Once the structures were constructed, all the maintenance work was the responsibility of the individual land users. However, by the time of fieldwork for this study, there was also a guard who protected the conserved areas from destruction by the free-grazing livestock. His payment was on food-for-work basis, which was 50kg of wheat per month. The grain was purchased with money from project sponsoring partners (like USAID) through the woredas' offices of agriculture and rural development. The community excused the guard from attending such social events and obligations as funeral, special church services, *mahber* and *indri*.

PART THREE

4.10 Implication of Land-use/cover Changes

i. Implications on Soil Degradation of the Study Area

Land cover is one of the factors that determine the rate of loss of soils due to erosion. It influences both factors of erosivity of the eroding agents and erodibility of the eroding subject (Morgan 1995). From the point of view of land exposure to erosive storms, typical of the area, the land cover types in the two woredas can be classified into two classes: i) the bare lands by the time of erosive rains; and ii) lands under good vegetative cover by the time of erosive rains, thus largely free from the threat of erosion. Cultivated fields and part of the open grazing lands constitute the first category, while the rest of the land cover types can be included in the second. Accordingly, part of the study area vulnerable to possible maximum soil loss accounted for around 60 and 76 per cent of the total area in 1993/4 and 2007/8, respectively. At the same time, the slightly increased forest cover in the study area cannot imply a lessened severity of erosion because most of these were areas under eucalyptus plantations, which would not reduce erosion due to the sparse canopies (FAO 1988).

ii. Implications on Land Degradation of the Study Area

The removal of natural vegetation cover for various reasons as explained above could lead to land degradation, such as deforestation and soil erosion through land exposure to the impacts of raindrops. This process accelerates detachment and removal of soil particles and its associated consequences (Morgan, 1986). The problem becomes worse where steeper lands are cultivated under intense seasonal rainfall (and high erosivity) in the absence of effective soil conservation measures (Belay, 1992), as has been the case in the study area. In the highland parts of the two woredas under discussion, among other factors, patterns of land cover and types of conservation measures are major determinants of rate of soil erosion. As elsewhere in other parts of the country's highlands, water erosion forms the dominant form of land degradation in the study area.



Poor land management, such as overgrazing and over cultivation of lands can easily lead to land degradation and desertification. A typical degraded land in La'elai Maichew woreda, tabya Natka Bila'e.

Considering the land cover status of the study area, the degraded and, cultivated and settlement land cover categories are more vulnerable to processes of land degradation, such as soil erosion. As a consequence, the potential proportion of land prone to soil erosion increased from 48.3% in 1993/4 to 89.6% in 2007/8 of the total area of the study area. There fore, on average, about 45.3 ha (2.9%) of the 1993/4 degraded land and, cultivated and settlement land cover area categories or 1.4% of the total area of the two neighbor woredas are potentially exposed to soil erosion per year. This implicates that, within the study area, cultivated and degraded land cover systems would potentially form major sources of soil erosion. There fore, the existence of spatial-temporal variability of potential environmental hazards (e.g.: soil erosion and deforestation) in the study area verifies the need for designing and implementation of land-use planning and management methods suited to local site conditions.

iii. Implications on Hydrological Balance of the Study Area

Land cover changes greatly interfere in the land phase of the hydrological cycle. Land under little vegetative cover is subject to high surface runoff and low water retention. The increased runoff causes sheet erosion to intensify, rills and guiles to widen and deepen. The masses of sedimentary materials removed from hill slopes accumulate downstream,

and there create problems of water pollution, reservoir in-filing and sedimentation of important agricultural lands. Following the above grouping of the land cover types into two, the total area of possible maximum runoff had increased between the analysis period. Also, the increased area under plantations cannot imply a salutary condition from the point of view of regulating hydrological balance of the woredas, because the tree species widely planted was eucalyptus, which has a reputation of being heavily thirsty.

vi. Implications on Food Security of Livelihoods

Accelerated soil erosion is primarily caused by farmers' land use practices. Likewise, the success of attaining food security in any given area depends on the extent of the given area's vulnerability to environmental catastrophes like soil erosion, deforestation etc...this in turn will lead to land degradation. If land is degraded, so does any cultivation of crop production which, with out question, will definitely affect food security of households.

Table 4.32 Implication on Food Security

	Implication on Food Security of HHs		% total
Time	1993/4	2007/8	0.4
HH No	1,013	9,894	8.41

Source: Study Area WoARD offices – Food Security , Disaster Prevention and Emergency Management Departments 2008

This particular incidence has been the common explanation behind the soaring problem of food security of rural livelihoods in the study area. Unless the undergoing efforts to check the magnitude of soil erosion and the better growth of crops along the soil and water conservation structures improve, livelihoods in the study area are most likely to continue facing food insecurity. Figures from the local agriculture and rural development offices show that food insecure households have increased by 8% since 1993/4 (*see* table 4.32) with little stability observed in very recent years since the intervention of the community based natural resource management, and the utilization of water schemes for small-scale irrigations.

v. Implications on Wild Animals Destruction

Wild animals such as hyena (*Crocuta crocuta*), Colubus monkey and Vervet monkey (*Cercopitheucus pygessythus*), warthog (*Phacochoerus ethiopicus*), cheetah (*Acinonyx jubatus*) and different types of birds used to be observed in the forest land prior to 1996. But it was not possible to quantify these animals and determine their dynamism in terms of their number. Nevertheless, as it has been the experience in the country so far removal of forest land (i.e. habitat of wild animals) means destruction of the animals not only in quantity but also in diversity. Moreover, local reports indicate that the two adjacent woredas were home of some high altitude animals, such as leopard (*Panthera pardus*), and *Menlik's bush buck* (Adwa and La'elai Maichew woredas Agriculture and Rural Development Offices, 2003). These latter animals were not observed since the 1970s, probably suggesting their extinction and/or out migration from the study area.

4.11 Current Government Rural Development Intervention in the Study Area

4.11.1 The SWC Measures under Implementation

The conservation measures that were under implementation during the study and planned to be implemented are discussed below:

A. Graded Soil, Stone and Soil Bunds

These structural measures are generally meant to break slope length and angle. By shortening the slope length and reducing the slope gradient, these measures suppress the velocity of runoff and thereby the kinetic energy (erosive power) of the overland flow. The soil bunds are earth embankments constructed across the slope with the ditch on their upslope side and the earth material excavated thrown down slope. The stone bunds are stone embankments constructed across the slope to act as a barrier to runoff and to retain sediments on their upslope side. Thus, these are structures made by digging a ditch and throwing the excavated earth material upslope to form the embankment. Upslope of the embankment acts as a barrier to runoff and provides storage space for soil sediments and nutrients. The trench in the down slope position of the embankment impounds any runoff that may spill over the embankment to safely drain it off the agricultural fields. Soil

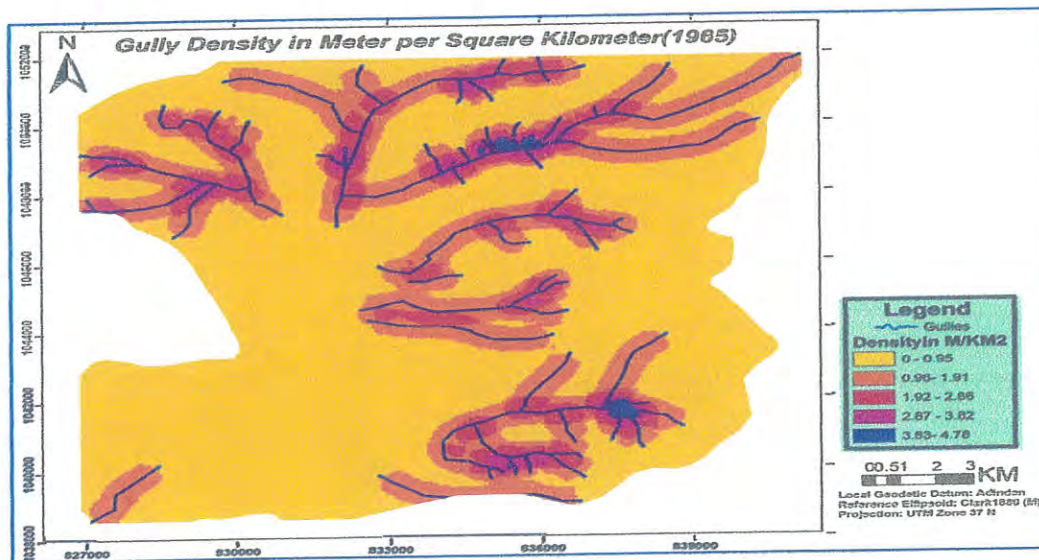
bunds are sometimes called converse terraces. By the time of this study (first and second years of the project), no stone bund was constructed. But a total of 60 have covered by the soil (4ha) and soil bunds (56ha) bunds. The design of these bunds was such that they were graded 0.5-1.0% and the vertical intervals were 1.0-2.0m, depending on the slope of individual fields. The ditches had a width of about 75cm and a depth of around 50cm.

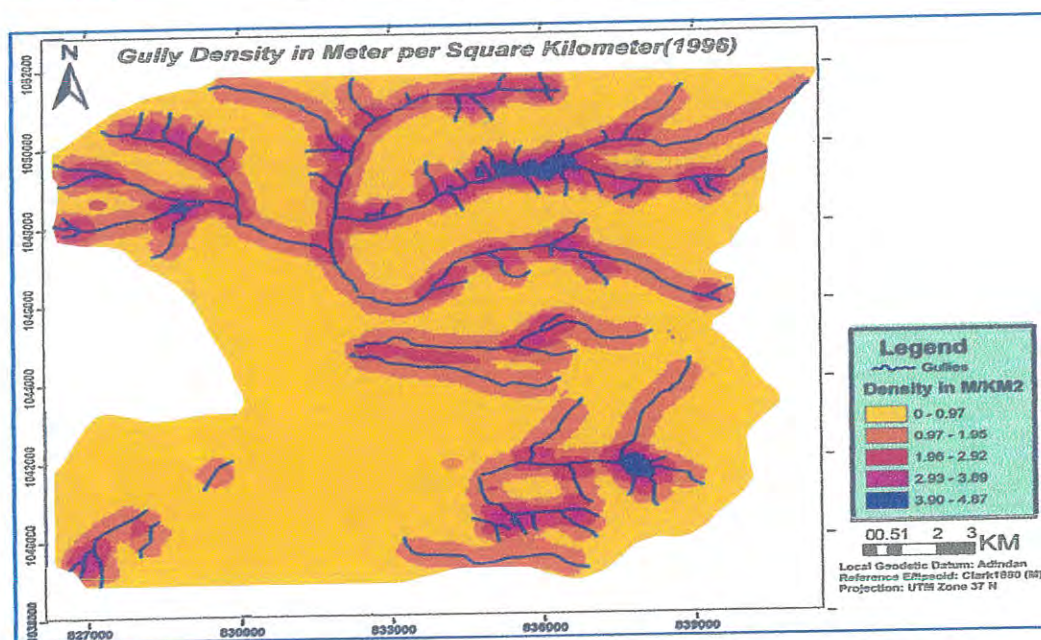
B. Cut-off Drains

The cut-off drains are open and graded diversion channels with a supporting embankment on their down slope position. These structures are constructed across a slope so that they intercept runoff coming from up slope, which is finally safely conveyed into a natural or artificer waterway. The embankment in the down slope position is meant to protect the runoff from spilling over the ditch and damaging fields located down slope. A total of 0.665km of cut-off drains was constructed above fields located on steep slopes, in the first and second years of the project.

Map 9

Gully Density in 1993/4 in the Study Area





Source: Ministry of Water Resources (MoWR) and the International Livestock Research Institute (ILRI)

C. Artificial Waterways

The artificial waterways, also called drainage ways, are man-made channels meant for collecting runoff from hill slopes, cut-off drains and bunds, and evacuate it safely into natural drainage systems, where it can empty into streams or rivers. The general technical requirement of artificial waterways is that it should possess sufficient dimensions to carry the runoff that will be generated from the prevailing rainfall conditions. Also, the channel needs to be established by planting grasses or paved with stones so as to protect its development into gullies. A total of 0.375km of artificial waterway was constructed in the first and second years of the project.

D. Check-dams

Check-dams are structures that are established across gullies to provide a physical barrier for the flowing water and initiate the process of sedimentation. They can be made of stone or tree shrubs. Check-dams encourage the growth of vegetative cover in the gully floors, providing protection against further erosion and establishing it. Check-dams can eventually raise the floor up to the level of surrounding and original ground. The slope of fields and runoff amounts that are generated during rainfall events determine the

dimensions and spacing of these structures. That is, the length of check-dams depends on the width of the gullies to be checked (or established and rehabilitation), and the width should not exceed from 1.0m and its height. The horizontal spacing depends on the gradient of the gully. The total length of check-dams constructed during the first and second years of the community based natural resource management intervention in the study area was 0.268km, and the overall plan was to build a total of 0.40km over the five years.

E. Agro-forestry Practices to Stabilize the Structural Measure

Agroforestry is the practice of planting and management of trees or shrubs in croplands and/or pasturelands to get economic and/or ecological benefits from the interaction between crops or livestock and the trees or shrubs. In agroforestry systems, the trees or shrubs can be grown with crops at the same time and in the same field or at the same time in adjoining fields or in the same field at different times. In Adwa and Lae'lai Maichew woredas, the agroforestry practice was designed to involve planting of shrubs and trees along the soil and water conservation structures, mainly meant to stabilize the bunds. Planting of trees and shrubs of multipurpose species on the, soil and stone bunds, on the bunds of cut-off drains, along the sides of artificial waterways and on check-dams were a component of the community based natural resource management activities. This agroforestry and afforestation components involved establishment of one nursery with a physical expanse of 0.25ha and a capacity of 200,000 seedlings. In the first and second years of the project, total 535,345 seedlings were produced and a total area of 29ha was covered by agroforestry plantations along the soil and water conservation structures.

In addition to soil and water conservation and soil fertility maintenance, the seedlings produced at the nursery were also meant for meeting the fuel and construction wood demand of the population and production of animal fodder. The species being tried were, therefore, multipurpose. The seedlings produced were of many species: *sesbania*, different species of *acacia* trees, *junipers*, *jacaranda*, *eucalyptus* and others. A total of 860,000 seedlings were planned to be produced in the five years and to be planted in the study area. The total area expected to be under plantations in the neighbor woredas was 160ha. Appropriate sites for planting of the trees, added to that along the soil and water

conservation (SWC) measures, were identified to be homestead compounds, farm boundaries, road sides, river banks and bare lands.

4.11.2 Planning of the Soil and Water Conservation (SWC) Works and Actual Implementation

Table 4.46 and 4.47 show the five years plan for the construction of physical SWC measures, and afforestation and agroforestry components of the project. The soil bunds were the most preferred structures. The rationale behind the preference was the soil bunds take less space than soil bunds and also transform into bench terraces over shorter period of time. Total of 150ha of land was planned to be treated with soil and soil bunds over the five years' period, consisting of 95ha soil bunds, 50ha soil and 5ha stone bunds. The task of constructing the physical measures was equally divided among the five years. According to the planning, maintenance of the bunds was to be carried out every year.

The agroforestry and afforestation works form integral part of the soil and water conservation measures. A total area of 160ha was expected to be under plantations by the end of the five years. Unlike the construction of the physical soil and water conservation measures, the production of seedlings and the agroforestry and afforestation works were not equally distributed among the five years (*see table 4.47*). The number of seedlings that were planned to be produced was 300,000 in the first and second years of the project, 360,000 seedlings in the third and fourth years and 200,000 seedlings in the last (fifth) seedlings in the third and fourth years and 200,000 seedlings in the last (fifth) year. Correspondingly, the areas that were planned to be under plantations were 20ha in the first year, 60ha in the second and third years and 80ha in the fourth and fifth years of the project.

Table 4.33 Plan for the Construction of the Various SWC Structures

Activity	Unit	Yearly plan	Total quantity
Soil bunds	ha	10.00	50.0
Bunds	ha	19.00	95.0
Stone bunds	ha	1.00	5.0
Cut-off drains	km	0.60	3.0
Artificial waterways	km	0.40	2.0
Cleck-dams	km	0.08	0.4
Maintenance of the bunds	ha	30.00	150.0

Source: Central Zone Agriculture and Rural Development Bureau (February, 2009)

Table 4.34 Plan for the Production of Seedling and Afforestation and Agroforestry activities

Activity	Total quantity	Plan for the five years				
		1 st year	2 nd year	3 rd year	4 th year	5 th year
Seedling Projection	860,000	150,000	150,000	180,000	180,000	200,000
Afforestation and agro forestry	160ha	20ha	30ha	30ha	40ha	40ha

Source: Central Zone Agriculture and Rural Development Bureau (February, 2009)

The actual implementation of the plan during the first and second etc... years of the project is shown in table 4.34. In both the first and the second years, for example, the actual implementation exceeded what was planned to be achieved in some of the activities, but fell below the planned in some others. In the first year, the construction of soil bunds and check-dams, and the projection of seedlings and the agroforestry works were accomplished at higher levels than planned. The actual implementation exceeded the planned by 42.1% in the soil bunds construction, by 135% in the check-dams construction, by 109.7% in the production of seedlings and by 45% in the agroforestry works. On the other hand, in the same year, the actual implementation of the construction of soil and stone bunds, cut-off drains and artificial waterways was below planned. Actual implementation of these works was 20% of the planned for soil bunds construction, 41.7% for the cut-off drains construction, 78.7% for the artificial waterways construction and none for the construction of stone bunds. The total labor input for the works accomplished in the first year of the project was 612 working days, estimated at Eth. Birr 4,284.00.

Table 4.35 Actual Implementation of the Soil and Water Conservation Plans

Activities	1993/4			2007/8	
	Unit	Planned	Implemented	Planned	Implemented
Soil bunds		10	2	10	2
Normal bunds	ha	19	27	19	29
Stone bunds	ha	1	-	1	-
Cut-off drains	ha	0.60	0.25	060	0.415
Artificial waterways	km	0.04	0.315	.40	0.060
Check-dams	km	0.08	0.188	0.08	0.080
Maintenance of the bunds	ha	30	-	30	60
Seedling production	km	150,000	314,851	150,000	220,764
Affor.and agroforestry	ha	20	29	30	-

Source: Central Zone Agriculture and Rural Development Bureau (February, 2009)

4.12.3 The Plantations on the Soil and Water Conservation (SWC) Bunds

In the second year of the project, construction of the soil bunds and projection of seedlings were accomplished at higher levels than the planned. The actual implementation exceeded the planned by 52.6% in the construction of the soil bunds and by 47.2% in the production of tree seedlings. On the other hand, the construction of the soil bunds, stone bunds, cut-off drains and artificial waterways and agroforestry works were below the planned levels. The actual implementation was 20% for the construction of cut-off drains, 15% for the construction of artificial waterways, and none for both the construction of stone bunds and the planting of trees for the agroforestry. The construction of check-dams was carried out as planned. Besides, maintenance works were done for all the bunds constructed in the two years (60ha coverage) in the second year of the project was 1704 working days, estimated at Eth. Birr 5,112.00.

4.11.4 Observed Changes in the Land Condition since the Community Based Natural Resource Management Intervention

Generally, effects of SWC works require a long period of time to be appreciable by the farmers. Yet, farmers can easily notice if there have been any visible changes in a short time as well. The farmers were asked during informal FGD discussions to mention any changes in the land condition they may have observed since the community based natural resource management intervention. The farmers responded that they have witnessed

changes in the land cover condition, level of soil erosion and better growth of crops along the SWC structures due to the entrapped sediments. The land cover condition improved, according to the farmers, for two reasons: i) the trial sites were closed and protected from encroachment by livestock, hence natural vegetation was returning in lands that were uncultivated for being too degraded, or gully sides and valleys, and ii) the trees planted on the soil and water conservation structures (agroforestry) increased the vegetative cover of the land. The farmers stated that they were using twigs of the plantations to feed their oxen, by the cut-and-carry system; hence, the changes in the land-use/cover condition had improved livestock feed availability.

The other changes the farmers mentioned were the decreased magnitude of soil erosion and the better growth of crops along the soil and water conservation structures. As stated by the farmers, the better performance of crops along the conservation structures was a result of the improved soil fertility status due to the decreased magnitude of soil erosion, which was the result of the conservation works. However, the improved crop yields were most likely due to the soil moisture conserved by the soil and water conservation (SWC) measures. Stayed in place was too short to effect significant improvements in the soil fertility status.

4.11.5 Farmers' Acceptance and Adoption of the Introduced SWC Technologies

Accelerated soil erosion is primarily caused by farmers' land use practices. Likewise, the success of any soil and water conservation intervention depends on the extent to which the introduced conservation technologies are accepted and adopted by the farm households. In other words, acceptance and farm-level adoption of the newly introduced conservation technologies by the farmers is the decisive element for the success of the community based natural resource management intervention, which envisages improved livelihood for the farmers through conservation-based agriculture. Table 5.36 shows the farmers' evaluations of the introduced SWC technologies in terms of their effectiveness in arresting soil loss and their potential to improving land productivity. These evaluations are good indications to gauge the level of acceptance of the introduced SWC measures by the direct beneficiaries- the farmers.

More than 98% of the respondents confirmed that the technologies were effective in arresting soil erosion. Similarly, the majority of the respondents (94%) believed that the new SWC technologies had the potential to improve land productivity and lead to increased crop yields, as they had already observed a better growth and development of crops particularly along the structures where that the newly introduced SWC technologies had generally obtained recognition on the part of the farmers as effective measures to combat soil erosion and improve land productivity.

Nevertheless, acceptance of the technologies as effective measures for controlling soil loss and as having potential to improve land productivity can not warrant its adoption on the farm. While acceptance depends more on the design characteristics of the technologies as related specifically to effectiveness, farm level adoption of the measures depends also on several socio-economic and institutional factors. The factors affecting adoption also determine the sustainable utilization of the measures by the farmers. Adoption of soil and water conservation technologies is a difficult concept to measure. Generally, newly introduced soil and water conservation measures can be considered as adopted if the land users (farmers) continue to utilize them as a part of their production system after the external assistance is withdrawn.

Although adoption of the soil and water conservation technologies can be effectively appraised only after the termination of the project. It can also be assessed by analyzing the farmers' attitudes, objectives and aspirations of whether they would like to use the introduced technologies as a part of their farming enterprise. Accordingly, the farmers were asked what their intentions were regarding using the introduced soil and water conservation technologies in the future (table 5.35). Some 42% of the respondents expressed their commitment to continue maintaining the established structures after the support ends. On the other hand, 58% stated that they would not maintain the structures as they were by them. Of the latter group, some argued that they would destroy every other structure so as to reclaim the "lost land" for cultivation; and some others stated that they would destroy some of the structures in order to use the fertile sediments retained behind. In addition to this, the farmers were interviewed whether they would like to apply the soil and water conservation technologies in the rest of their farm fields (plots that

were not treated by that time). Some 78% of the respondents responded negatively, while only 22% expressed willingness, but only so long as they could be provided with labor assistance for the implementation of the measures.

In summary, it can be stated that the introduced soil and water conservation technologies were widely acknowledged and acetated as effective measures against soil erosion and as having the potential to improve land productivity. Nonetheless, their sustainable adoption on the farm level appears to be less likely.

4.11.6 Factors Affecting Farm-level Adoption of the Introduced SWC Technologies

The farm-level adoption of SWC technologies depends on several interrelated factors. Effectiveness of the technologies in arresting soil loss is only one consideration. As discussed above, the majority of the surveyed sample households acknowledged the introduced SWC measures to be effective in controlling soil erosion and as having the potential top improve land productivity. On the other hand, the majority of the respondents did not appear to have intentions or plans to continue maintaining the structures established by the mass work. Similarly, the majority of the respondents stated that they had no intentions of applying the technologies in their farm plots that were not treated by that time; this also implied that there was a very little chance for the farmer-to-farmer diffusion of the improved technologies.

Accepting the technologies as effective measures to control soil loss and improve land productivity on the one hand and showing disinterest to adopt them on the farm on the other might appear surprising. Yet, it is in agreement with findings of some research works elsewhere rather. According to Semgalawe (1998), farmers rather frequently reject newly introduced soil and water conservation technologies even when they are aware that adoption of the measures protects and improves productivity of their lands. This suggests that the newly introduced soil and water conservation technologies need to be evaluated not only for their technical efficiency but also for the chances of their sustainable adoption and utilization by the land users. The latter requires identification of barriers to and facilitators of adoption of the technologies. Once the barriers and facilitators are identified, recommendations can be made on appropriate steps that need to be taken to

enhance the adoption of the technologies and to effect sustainable land use. In this section, some personal, socio-economic and institutional factors that are affecting a sustainable adoption of the introduced soil and water conservation measures by the farmers are discussed.

A. Perception of Soil Erosion as a Menace to Crop Production

Perception of soil erosion as a hazard to crop production and sustainable agriculture is the most important determinant of effort at adoption of conservation measures. Understanding and recognition of soil erosion as a problem in own farm plots and its cause and impacts on crop yields are the first step towards searching for and adoption of remedial measures. According to Osgood (1992), public awareness of the soil erosion problem and the need for soil and water conservation is generally low. The underlying reason for this is the fact that the process of erosion is gradual, which goes on unnoticed and is recognizable only after reaching some threshold levels. This is usually a point where it is very difficult for the subsistence farmers to arrest it with their meager resources and technical capabilities. As Hurni (1985) argues, when the public awareness and perception of the problem seems widespread, it must be degradation has reached critical proportions. According to Hurni (1985), farmers in northern Ethiopia seem to have realized that their land is being degraded after centuries of farming, when it had already become a severe problem to food production.

Once farmers perceive soil erosion as a problem having negative impacts on soil quality and land productivity and expect positive returns from soil erosion control, it is highly likely that they will decide in favor of adopting available conservation technologies. On the other hand, when farmers do not acknowledge soil erosion as a problem, they cannot expect benefits from controlling the erosion process and it is highly likely that they will decide against adopting any conservation technologies.

In Ethiopia, there are some studies that deal with the farmers' perception of soil erosion. The results are apparently contradictory. According to Hurni (1985), "low perception of needs to be circumvented to SWC efforts in the country. On the other hand, Belay (1992) concluded that farmers have a good perception of the problem of soil erosion. Berhe and Chadhokar (1993) also believe that there has been some level of awareness of the

problem of land degradation throughout the country and, that range of traditional conservation measures are in place now. More recently, a study by Omiti et al. (1999) shows that farmers are well aware of the problem of land degradation, stating that 85% of the households conversed in their survey (n = 892) mentioned erosion as an important economic problem. Table 5.36 shows the farmers' awareness and perception of the erosion problem in the study area.

As shown in table 4.46, the majority of the surveyed farmers (98.4%) acknowledged that soil erosion was a problem in their own farm. Regarding signs with which it can be identified, they rightly mentioned visible erosion features, rills, gullies and landslides. The causes to the soil erosion problem mentioned by the farmers included: the slopes were very steep (40.6% of the respondents) and the soil were very erodible (20.3% of the respondents). Runoff from up-slope areas and dup-slope lands being too degraded were also mentioned by some of the respondents. Concerning the intensity of the problem, the ratings were 'severe', "Moderate" and "minor" by 78.1% 17.2% and 4.7% of the respondents, respectively. The majority of the respondents (84%0 also witnessed that they observed an increasing trend in the severity of soil erosion over the past ten years. On the other hand, some 14.1% of the respondents believed that soil erosion has become less and less severe over the same time period, while the rest of the respondents replied that they did not observe any change.

The farmers were also asked to rate the impact of the soil erosion on crop yields. The ratings were "Severe", "Moderate" and "has no impact all" by 51.6%, 46.9% and 1.6% of the respondents, respectively. Comparing the number of respondents who rated the impact of erosion on crop yields as "moderate" to the number of respondents who rated the intensity of erosion as "severe", it can be stated that the link between soil erosion and decline land productivity is possibly obscure to the farmers. Additional evidence to this assumption is the explanation given by the farmers during FGD discussions about decline in fertility levels of their lands. They generally agree there is a problem, but they attributed this to "be a problem of the land" due to overuse.

Table 4.36 Farmer Households' Perception of Erosion Hazards

Perception on erosion	HH Response (%)of total
Whether erosion was perceived as a problem in own farm	
Yes	98.4
No	1.6
Severity of the problem, if yes to the above question	
Severe	78.1
Moderate	17.2
Minor	4.7
Observed change in erosion intensity over the last 10 years	
Has become more severe	84.4
Has become less severe	14.1
No change	1.6
The perceived major cause of soil erosion	
Slopes being very steep	40.6
Rainfall being too much	14.1
Soil being too erodible	20.3
Runoff from up-slope areas	4.7
Uplands being too degraded	3.1
Extent of impact of erosion on crop yields	
Severe	51.6
Moderate	46.9
Minor	1.6
Believe that erosion can be controlled	
Yes	96.9

Source: Central Zone Agriculture and Rural Development Bureau (February, 2009)

The total does not add up 100% because some of the respondents gave a combination of factors as equally important; e.g., slopes being very steep and rainfall being too much (6.3% of respondents).

In general terms, it can be concluded that the farmers were well aware of the problems of soil erosion and land degradation. Also, the farmers generally believed that erosion could be controlled (97% of the respondents). Hence, their lack for interest to adapting the introduced SWC measures cannot be explained by lack of awareness about the problem. This finding also suggests that correct perception of soil erosion as a problem is a necessary but not sufficient condition for the farmers to adopt improved SWC technologies. Indeed, awareness about and correct perception of soil erosion as an economic problem is only the martial step in the adoption-decision making process. After

the perception of erosion as a threat to crop production and the willingness to adopt conservation measures, the ability of the farmers to do so become the most important factor. The ability of farmers to adopt SWC technologies is related to their labor supply and economic status.

B. Households' Labor Supply

In Adwa and Lac'lai Maichew woredas, like in any other subsistence economies, household members are the suppliers of labor needed for the implementation of the soil and water conservation measures, and indeed for the whole farming operation. The soil and water conservation measures under implementation physically require a lot of labor. As Stocking and Abel (1989) estimate, 40 working days will be required to install simple biological measures per ha; construction of bench terraces on one ha of steeply sloping, therefore, determines its ability to maintain the soil and water conservation measures already established and to construct new ones. Household size in reference to landholding sizes was taken as an indicator for labor availability in this study (table 5.43). Obviously, farm households with fewer labor constraints can be more able and willing to adopt SWC measures while households with more labor constraints will be unable and less willing to do so.

As can be seen in table 4.47, the majority of households seem to have adequate supply of labor that would be needed for the SWC works in their small holdings. Some 54.7% of the total households had 4 to 6 members and some 21.9% had 7 to 9 members. In contrast, 56.2% of the households possessed only 0.6 to 1.0 ha of land. Only 9.4% of them owned more than 2 ha. Taking the average household size and the average land holdings of the households, the per capita holding was 0.24 ha. From the land holding patterns and family sizes, it might be inferred that labor availability could not be a constraint for the farmers to implement the introduced SWC measures. To substantiate the inference, the farmers were explicitly asked whether labor shortage was a problem for them to apply the introduced SWC measures. The answers failed to reinforce what seemed to be a logical inference from household size and land-holding patterns. Unexpectedly, the majority of the households (81.3%) responded that shortage of labor was one of their major problems to maintain the SWC structures established in their plots

by the mass work and also to plan to implement the technologies in the rest of their plots.

Table 4.37 Household Size, Land Holding and Labor Condition of Households

Factor	% of total
Household size (no)	20.3
≤ 3	54.7
4-6	21.9
7-9	3.1
≥ 10	
Total land held (ha)	
≤ 0.5	14.1
0.6-1.0	56.2
1.1-1.5	9.4
1.6-2.0	10.9
> 2.0	
Facing labor shortage to apply the introduced SWC measures	
Yes	81.3
No	18.8

Hence, an explanation to the fact that the farmers were disinterested in adopting the introduced soil and water conservation works is to be found in the problem of labor shortage. This finding is in agreement with the argument by Semgalawe (19980) that farmers will refrain from adopting new SWC technologies if the labor required for the implementation is thought to be too high relative to capacity of the household. At the same time, it is contrary to the general belief that labor availability is not a major problem to subsistence farmers in developing countries to apply improved SWC measures. The latter view stems from the assumption that disguised unemployment is rather rampant as many people are accommodated by small land holdings. Because of this, labor availability is the factor generally considered available at the planning stage, and undervalued at the stage of evaluation of SWC projects (Stocking and Abel 1989). The finding in this section adds to the existing little evidence in the Ethiopian situation that such a view on labor availability to SWC works is rather worn.

C. Land Tenure Security

Land tenure security has been shown to be an important factor, besides farmers' awareness and labor availability, affecting subsistence farmers; decisions whether to adopt introduced SWC measures. The general agreement is that the land users must have

secure property ownership rights of the lands they cultivate if they are to invest in SWC works in anticipation of long-term benefits. That is, in a situation where the farmers are not certain to capture the benefits of investment in SWC on their lands, they will not be willing to devote much effort to SWC. In other words, secure ownership of the land operated increases the sense of responsibility and lengthens the farmers' planning horizon and thus they will be more concerned about the proper use and management of the land.

In Ethiopia, land has been under state control since the 1975 land reform. The land users (farmers) have been given only usufructory rights. It is believed that this property ownership regime has been a source of insecurity for the farmers to invest on their small plots of land for long-term benefits. Studies in different parts of the country have tried to show empirically that land tenure insecurity significantly influences farmers' decisions on land management practice. For instance, (Kebede, 1989) mentions that the absence of clear and unambiguous property ownership rights was one of the reason for the failure of past attempts of environmental rehabilitation and conservation works, specifically that on communally held hillsides. The destruction of those hillsides closed for natural regeneration in the northern highlands of the country during the change of government in 1991 was attributed to uncertain land ownership system (Yeraswork 2000). In his study in a West Shewa Oromo community, Mirgissa (1994, 123) concludes that "due to ownership insecurity, people nowadays have no concern about resource conservation". Belay (2000) has identified the insecure land tenure system as having contributed to the accelerated soil erosion from cultivated fields in the south Wollo highlands of Ethiopia.

Despite this information that seems convincing, land redistribution was conducted in the study region (Tigray Regional State) at the beginning of 1991 with no form of compensation to the losers for long-term investments such as building terraces. Therefore, would it also be because of the insecure land tenure that the majority of the surveyed farmers were disinterested to adopt the newly introduced SWC technologies?

The questions in table 4.48 were meant to see to the influence of security of land tenure on farmers' decisions to invest in the soil and water conservation works. As it can be seen, 58% of the respondents expected land redistribution in the future, 39% did not

expect land distribution, while the rest reserved themselves from giving any prophecy on the subject. The majority of the respondents (around 41%) reported that they lost held plots during the 1997 land redistribution. On the other hand, a considerable number of the respondents (32.8%) reported that they had no land before and gained by then, while a few households (9.4%) also gained additional plots. Only 14% of the respondents reported that their holdings remained unaffected. Given this dynamics of land holdings, it can be argued that the unstable land tenure system must be partly responsible for the disinterest shown by the farmers to adopt the introduced SWC measures, which inherently have long gestation periods.

More explicitly, the farmers were asked about whether the periodic redistribution of land could in any way affect their decisions to adopt the introduced SWC measures. More than 73% of the respondents asserted that it discourages them from adopting the measures. The rest of the farmers responded that it does not affect their decisions to adopt or not to adopt the technologies. Therefore, with this empirical information, it can be concluded that the insecurity of tenure over the lands they operated was one factor towing back farmers from making efforts to adopt the introduced SWC measures. It was also learned during informal discussions with farmers that security of tenure was an important factor given the labor input required to implement the measures. One farmer (who had lost a plot of land during the 1991 redistribution) compared the plot of land in his possession to a rented house, where the landlord can dislodge the tenant at any time he wants his house vacated.

This finding is in agreement with severe empirical studies carried out in different parts of the country (e.g., Kebede 1989; Mirgissa 1994; Yeraswork 2000). The implication is that securing land rights will be an incentive for the farmers to adopt improved SWC technologies.

Table 4.38 Effect of the 1997 Land Redistribution on Individual Holdings and Farmers' Opinions on aspects of Land Tenure

Question	% of total
Do you expect land redistribution in the future?	
Yes	57.8
No	39.1
Can't know	3.1
Can periodic land redistribution in any way affect your decisions on adopting SWC measures?	
It discourages me	73.4
It does not have any affect	26.6
How did the 1991 readjustment affect your holding?	
Held plots lost	4036
Additional plots gained	9.4
Previous holding remained unaffected	14.1
Had no land before and gained by then	32.8
Some plot but same size replaced	3.1

D. Fitness of the Technologies to Farmer Requirements and Farming System Circumstances

The farmers' decisions on whether to adopt SWC technologies at the farm level also depend on the fitness of the technologies to their needs and requirements. Some of the most important characteristics of conservation technologies or techniques that influence the farmers' adoption decisions are effectiveness in controlling soil loss; benefits to be obtained from adoption, the ease of adoption and appropriateness to the farming system circumstances. If newly introduced SWC technologies do not appear to be relevant to the farmers in view of these criteria, it is highly unlikely that they will be adopted and, indeed, should not be expected to be adopted.

In the study site, the SWC technologies under implementation were physical structural measures. These measures were acknowledged by the farmers to be effective in controlling soil loss and also as having the potential to improve productivity of generating benefits, which is in this case the potential to improve crop yields. The perception of benefits in the short-term in particular can be a good source of motivation for the farmers to make more efforts to adopt the new SWC technologies'. However, the farmers also mentioned problems associated with the technologies that were discouraging

them from planning to maintain the structures after the end of the project and for not intending to apply the measures in the rest of their farm plots that were not treated by the time (table 4.48).

As can be seen from table 4.39, the majority of the farmers (83%) believed that the newly introduced SWC technologies had very difficult designs, which they would be unable to apply without external assistance. The other aspect mentioned as a problem was the land space these physical measures occupy. Nearly 94% of the respondents believed that the technologies put too much land out of production. As was learned during focus group discussions, the shortage of land had made the farmers abandon their age-old practice of fallowing leave alone putting a part of land out of production. According to the farmers, the introduced soil and water conservation technologies will only be adopted if they can generate balancing benefits in terms of increased crop yields. During the first and second years of the study project, the increases in crop yields were not large enough to compensate for the “lost lands”, according to the farmers, the introduced SWC technologies will only be adopted if they can generate balancing benefits in terms of increased crop yields. Furthermore, the farmers had much complaint about the inter-structure spacing. According to them, the spacing of the bunds was too narrow, which made it land-consuming, a problem for ploughing with oxen and more labor-demanding for construction as well as maintenance. In this opinion, it was sufficient to preserve every other bund and destroy the middle ones.

The labor required for the construction and maintenance of the conservation structures was the other factor the farmers mentioned as a hindrance to adoption. More than 92% of the respondents expressed that the technologies were too labor-intensive for them to implement in their plots of land. Similar views were also stressed during focus group discussions with the development agents (DAs). The farmers frequently describe the conservation structure as “back-breaking”. From their point of view, the SWC structures had the potential to improve land productivity and increase crop yields, but that benefit would remain incommensurate with the physical work required for their implementation.

The farmers further added that the construction of the SWC structures was only in level and moderately slopping lands, while their major problem was the occurrence of landslides on steeper slopes. Thus, in their opinion, the community based natural resource management intervention was not addressing the priority and preference of the local people. The same was also learned during focus group discussions. The preference transpired by the majority of the farmers was the treatment of steeper slopes, which were still under cultivation but were left unattended by the project and suffered from severe damage due to mass movements.

Table 4.39 Farmers' Evaluation of the Introduced SWC technologies

Perception and opinion	% of total
The newly introduced SWC technologies have very difficult designs to implement by myself	
Yes	82.2
No	17.2
The new technologies require too much labor to implement	
Yes	92.2
No	7.8
The new technologies put too much land out of production	
Yes	93.8
No	6.3

The other concerns the farmers expressed was the lack of fitness of the introduced SWC technologies to the local farming system circumstances, particularly their being in conflict with the traditional tree-roaming grazing system. By the time of fieldwork for this study, the treated lands were being guarded from encroachment by livestock. The wage for the guard came from the organization that sponsored the community based natural resource management activities. The end of the program would thus bring the job of the guard to an end. When this happens, the farmers felt certain that the free-roaming grazing of livestock would resume in the se protected areas as well and cause destruction of the SWC structures- and the trees and shrubs planted on the structures.

The findings reported in this section generally ally with findings of other similar studies. Relevant examples include: Mohammed and Tassew (2006) in southeastern Ethiopia Chirokella Micro-watershed; Belay (1992) in northeastern Ethiopian highlands (Derekolli catchment, in south Wollo); Kibrom and Hedlund (2000) in Shire District, Western Tigray

zone, north Ethiopia, and elsewhere by other researchers. Especially, Kibrom and Hedlund (2000) have found out that the farmers were willing to conserve their soils and lands but demanded for more appropriate technologies. Other studies elsewhere have also concluded that farmers fail to adopt or adopt SWC technologies not for lack of concern to sustainable land use but for inappropriateness of the technologies provided. For instance, Kerr and Sanghi (1992) have reported that in India's semi-arid tropics, farmers failed to maintain or even intentionally ruined introduced SWC measures because the measures were not sustainable to other small farmers.

E. The Approach Followed in Implementing the SWC Measures

Earlier politics and strategies of SWC were generally similar over many countries of the world, including Ethiopia. Local farmers were seen as problems to efficient and sustainable utilization of the land resource. The objective of conservation was then resources protection from destruction by the farmers who tend to exploit with no restraint (Pretty and Shah 1999). From this perspective, it would be logically convincing to adopt top-down planning and imperious implementation of soil and water conservation measures. Most of the decisions were thus made in offices far removed from problem areas and with the people most appropriate least involved. Evaluation reports of such conservation undertakings more commonly than not contained some failure stories as well as stories of farmers' reluctance to continue with the introduced "scientific" practices as the coercive force withdrew (Pretty and Shah 1999). The same experience is found in Ethiopia. The following of top-down approaches and lack of genuine involvement of the farmers were some of the major reasons for the failure of past conservation initiatives.

So, putting aside the conventional view that the farmers are part of the problem of resource degradation, it is today acknowledged that they rather have basic and beneficial roles to play in sustainable land use and management (*see* Hinchcliff et al, 1999). This new thinking is what is popularly referred to as "bottom-up" or "participatory" approach in the SWC and development literature. The need to involve local farmers in all the processes of SWC activities, or broadly in watershed management, is at the present

widely accepted. The same is also endorsed in the environmental policy document of the Ethiopian government (FDRE 1997).

The problem lies, however, in defining the understanding what a participatory approach really means and in actually putting it into practice. Farmers are often said to [participate while they indeed are involved only in the implementation of the SWC measures engineered for them by subject-matter experts elsewhere. This is not participation in the real sense. Participation should mean the genuine involvement and co-operation of the farmers beginning from the identification of the soil erosion problem to the selection, designing, implementation and evaluation of effectiveness and efficiency of the conservation technologies. In short, for a SWC initiative to be regarded as truly participatory, the farmers should be convinced, as much as the experts and organizations involved, of that effect. The types and designs of the technologies ought to be determined based on consensus or on the majority opinion of the people. Table 5.46 presents responses of the farmers about the nature and extent of their involvement in the SWC venture in the study area.

Table 4.40 Farmers' Participation in the SWC undertakings

question	% of total
How are you participating in the newly introduced SWC activities?	
Voluntarily	43.7
Forced to participate	56.3

As shown in table 4.40, nearly 44% of the surveyed households asserted that they were participating the SWC activities, at their own conviction and voluntarily. On the other hand, more than 56% of the respondents reported that they were participating because they were forced to do so. Given that the majority felt coerced to be involved in the conservation works, it is difficult to enunciate that the watershed management project had followed real participatory processes.

As it was also disclosed during the focus group discussions, the farmers felt that their involvement was largely limited to the implementation of the measures brought in by the experts. According to information collected from these discussions, less chance was given to the farmers to decide on the types and designs of the SWC technologies, i.e., at

the planning stage. The chance the farmers acknowledged as having been given was to comment on the SWC structures only structures were implemented, on which they have lodged complaints particularly about the inter-structural spacing.



A typical slope area in Adwa woreda rehabilitated by soil and water conservation (SWC).

In addition, the community based natural resource management project appears to have ignored the farmers' time-honored knowledge in dealing with the soil erosion problem. Some 83% of the farmers reported that the SWC technologies introduced were totally new and unknown to them. As Chambers, Pacey, and Thrupp (1993) argue, if success is to be achieved, the farmers' indigenous knowledge should be at the foundation of a "modern" technology to be introduced. The argument is that building upon indigenous knowledge systems will boost farmers' self-reliance and the feeling of empowerment as determinants of their own course towards and improving livelihood and sustainable land use. However, the farmers did not even seem to be clear about whom the conservation works belonged to. For instance, many of the farmers believed that the employment of the guard should be permanent so that the conserved lands remain protected from encroachment by livestock. Otherwise, the free-grazing livestock would cause destruction of the structures as well as the trees and shrubs planted on the structures. The shows that the farmers did not feel obliged about the maintenance and sustainability of the soil and water conservation measures.

The finding in this section does not corroborate what was learned from the DAs working in the sites. According to the DAs, the farmers were willingly participating in the community based natural resource management activities, and their participation was ensured right from the very start and before the beginning of any actual work on the ground. However, the farmers stated that their involvement was largely limited to labor contribution, and what was done in the name of participation was more of community consultation.

The approach pursued in implementing the community based natural resource management practices was, therefore, closer to the conventional approach by which SWC works-mostly structural measures were constructed in many countries of the world including Ethiopia. Experience has shown that structures constructed without involvement of farmers out of their veritable commitment eventually end up failures- the very reason that justifies a participatory process. As the pressure recedes, farmers will fall back on to their traditional practices, land will continue to be degraded and food insecurity will grow. Therefore, for the conservation structures implemented in the study area to be maintained in the fields, it appears that steps remained towards a real participatory process in their construction.

CHAPTER V

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusions

In the neighboring woredas under discussion, as is the case in much of rural Ethiopia, the people are very poor, living on an average annual income of Birr 1038.70 per household, which has 5 members on average. Crop production and livestock rearing contribute to 92.7% of the total annual income of the households and 7.3% was secured from sale of trees and wood. Only very few households are found to be engaged in off-farm activities as additional sources of income, indicating the heavy dependence on the land. Land and livestock are the bases of livelihood for the people. On the other hand, land has become scarce and land holdings per household have been declining because of the increasing population. Moreover, productivity of croplands has declined over time due to “ageing of the land”, drought, soil erosion and inability to use chemical fertilizers because of its high cost. The scarcity and decrease in productivity of croplands has thus contributed to lower production of crops. There has also been a decreasing trend in the number of livestock owned by households, contributing towards poverty of the people. On the other hand, increase in the human population has caused an overall increase in the total livestock population in the communities, creating pressure on grazing lands and shortage of feed. The shortage of feed was identified to be one of the main reasons, the other being drought, for the decrease in the number of livestock owned by the households. Not only does the heavy grazing affect clearing of vegetation and the subsequent effects on the grazing lands but also affects cultivated lands, in much the same way, because free-roaming feeding on crop residues takes place after harvesting. The people in the study area are, therefore, facing problems of poverty and resource degradation, which require prudently composed solutions that integrate development and conservation measures.

The study has attempted to empirically assess the implication land-use change has on livelihoods in the study area; acceptance and adoption of community based land and natural resource management technologies introduced to them by government rural development interventions. Changes in land cover/use and magnitudes and rates of soil

loss due to rills were used as measures of the land degradation process. The results of the investigation of land-use/cover change indicate that over the fifteen years considered, there have been changes in the land cover, but the main type remained agricultural use. The major changes observed were the increase in cropland and shrub land areas at the expense of the open grazing and woodland areas. The increase in the area of croplands has implication on runoff generation, erosion, flooding and sedimentation problems. The results of the rill erosion survey indicate that, assuming 1 30% contribution from in Terrill erosion, soil loss was around 37 t/ha/year. This estimate, which is well in agreement with results obtained from soil erosion intensive studies in the same study area, shows that soil erosion is a threat to agricultural production and conservation measures are seriously needed.

There have been a range of land management and development works underway in the two adjacent woredas since January 1995, of which this study focused on the soil and water conservation measures. The introduced soil and water conservation measures have generally received acceptance by the local farmers. They are widely acknowledged as being effective measures in arresting soil erosion and having the potential to improve land productivity. Notwithstanding, the sustainable adoption and widespread reliability of the introduced soil and water conservation measures seem less likely. The majority of the surveyed farmers have stated that they have intentions to maintain the conservation structures. Also, the majority of the farmers stated that they would not like to apply the conservation measures in their plots of land that were not treated by that time. The major factors that were discouraging the farmers from adopting the introduced SWC technologies on their farms were found to be the labor shortage, land tenure insecurity and problem of fitness of the technologies to the farmers' requirements and to the farming system circumstances.

The problem of fitness of the technologies to the farmers' requirements and the farming circumstance partly are reflections of a problem in the approach followed in the planning and implementation of the technologies. Though it was claimed that participatory procedures were followed, facts on the ground did not seem to support this. For instance, the farmers' time-honored knowledge and preferences were ignored in dealing with the

soil erosion problem, as shown by the fact that 83% of the surveyed farmers reported that the introduced soil and water conservation technologies were totally new and unknown to them. Instead, the involvement of the farmers was limited to labor contribution. Real participatory processes were, thus, not followed. In a real participatory process, the farmers are the starting point. It starts with analysis of farmers' circumstances, problems, indigenous knowledge and preferred solutions to problems (Chambers, Pacey, and Thrupp 1993). Conservation experts and facilitators of implementation are expected to fine-tune conservation technologies to the needs of the people, and not otherwise. As Chambers, Pacey, and Thrupp (1993, 182-82) succinctly write, "(In a participatory approach), the main objective is not to transfer known technology . . . what is transferred by outsiders to farmers is not a package of practices to be adopted but a basket of choice from which to select".

5.2. Recommendations

The rural households in the study area are very poor, living on very meager annual incomes. Land and livestock are their fundamental bases of livelihood. On the other hand, land degradation, particularly soil erosion from cultivated fields, is a threat to their agricultural production, and conservation measures are needed. The introduced SWC have generally obtained acceptance by the farmers in terms of being effective in soil erosion control and potentially improving productivity of croplands. Nonetheless, few things need to be reoriented to ensure sustainable adoption and widespread replication of the technologies by the farmers, as findings of the study suggest.

- i. The high labor requirement for construction and maintenance was one of the reasons given by the farmers for intending to dismantle some of the introduced SWC structures after the external intervention comes to an end. The farmers expressed that the soil and water conservation structures have the potential to improve land productivity and increase crop yields, but they fear that the benefits might remain incommensurate with the physical work required for their implementation. Hence, reducing the labor requirements will contribute towards enhancing the adoption of the conservation technologies. The labor required would be reduced by increasing the spacing between the structures, which rescues

the total number, length and area of these structures. In addition to reducing the labor requirement, increasing the inter-structural spacing also reduces the total area of land that would be put out of production due to the structures, which was one source of complaint by the farmers. Increasing the inter-structural spacing will also ease the problem of ploughing with oxen, caused by the narrow spacing. However, this technical solution has disadvantages as well. That is, the measures will be less effective in terms of controlling soil erosion. In this regard, considering alternative technologies such as minimum tillage methods and putting greater emphasis on biological measures, instead of the physical ones, will help in reducing labor requirements without compromising the erosion control effectiveness.

- ii. Insecurity of tenure on lands operated was identified to be one of the constraints for the farmers to adopting the conservation measures. Therefore, secure rights on land should be granted to the people to enhance adoption of the conservation technologies. Granting tenure security does not necessarily mean privatizing land. It suffices to give the farmers assured use rights over sufficiently long periods of time during which they could reap the benefits to be derived from their conservation investments.
- iii. The problem of fitness of the technologies to the farmers' requirements and the farming system circumstances was one of the barriers to the adoption of the introduced SWC technologies. The ease of adoption and appropriateness to the farming system circumstances are some of the most important characteristics of conservation techniques they influence farmers' adoption decision, in addition to effectiveness in controlling soil loss and benefits to be obtained from the adoption. The majority of the surveyed farmers believed that the newly introduced SWC technologies have very difficult designs that they were unable to apply the structures in the absence of external assistance. Hence, training should be given to the farmers on the designing of these measures. The farmers should also be provided with the necessary equipment with which to align the structures.
- iv. The other concern of the farmers was the incompatibility of the introduced technologies to the traditional free-roaming grazing system. During the time of

fieldwork for this study, the treated lands were closed off from livestock by a guard employed by the project. But when the employment of the guard comes to an end with the ending of the project, the farmers were certain that free-roaming grazing of livestock would resume and cause destruction of the established structures as well as the trees and shrubs planted on the structures. Hence, the local people should be convinced, before the project ends, on taking the responsibility of protecting the treated areas from destruction by livestock. As much as possible, livestock grazing should be limited to the grazing lands. The stall-feeding system should also be introduced to the farmers.

- v. There was also lack of addressing the priority and preference of the local people by the project as related to the soil conservation works. As noted by the farmers' the construction of the SWC structures was carried out in level and only moderately sloping lands, while their major problem was the occurrence of landslides on steeper slopes. Thus, the SWC intervention was not addressing the priority and preference of the people. Their preference was the treatment of the steeper slopes, which were still under cultivation but left unattended and suffered from severe damage due to mass movements. There is, therefore, the need to address this priority of the farmers. Landslides can be prevented by afforestation of hillsides (sources of the direct runoff) and by construction of cut-off drains that divert the runoffs from entering into cultivated fields by coming from the up-slope sources areas. Tacking priorities of the farmers will serve as an effective doorway to the willing and committed participation of the farmers in the conservation undertakings.
- vi. The problem of fitness of the technologies to the farmers' requirements and the farming system circumstances is partly a reflection of a problem in the approach followed in the stage of planning of the conservation intervention. The approach followed was more of a top-down type where the participation of the farmers was limited mainly to labor contribution during implementation of the technologies. For a SWC initiative to be regarded as truly participatory, the farmers should be convinced, as much as the experts and organization involved, of the need for erosion control and the types of technologies to be applied to that effect. The

types and designs of the technologies ought to be determined based on consensus or on the majority opinion of the people. Hence, a thorough reassessment and reorientation of the approach being followed towards real participatory processes is important to ensure the sustainable utilization of the technologies by the land users.

- vii. By the time of the fieldwork for this study, the community based natural resource management trial site did not cover the whole of the study area. It was only part of the two neighboring woredas that was included. This needs to be corrected, i.e., the whole of the study area should be taken as the land management unit because conservation in a part of a given area will have little effects if the other parts particularly in higher positions are not conserved. For instance it was noted during the rill erosion survey that the formation of rill was basically a result of surface runoff and the associated sheet-wash processes. Much of the surface runoff was either entering into the fields from upslope areas or/and generated by processes of within-field concentration of runoff. The runoff leaving fields, in turn, caused erosion and/or sedimentation problems in fields located downstream. This physical interdependence clearly shows that conservation in one farm will do little if the other farms in a higher position are not conserved. Thus, the problem of erosion and SWC needs to be tackled in the study area context and the natural resource management activities should cover the remaining part of the study area.
- vii. Finally, lasting solutions to the problem of resource degradation caused by land-use change and rural poverty should include easing population pressure on the resources, technological improvements in agriculture and development of the other sectors of the economy. Involvement of the local people is essential in all initiatives of conservation and management of natural resources.

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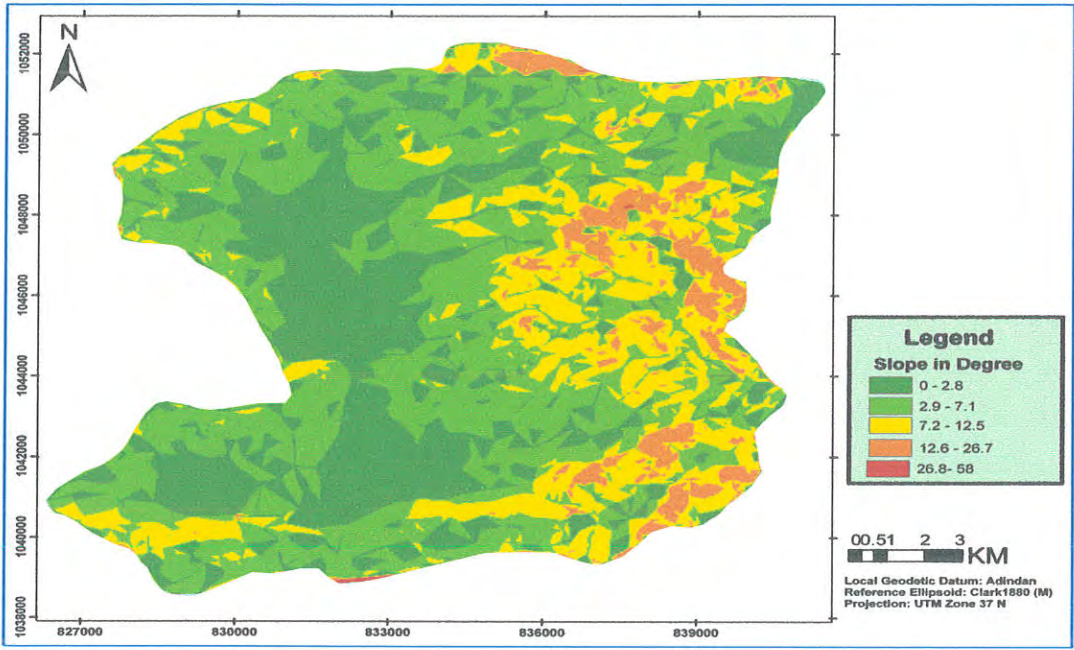
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ANNEX I

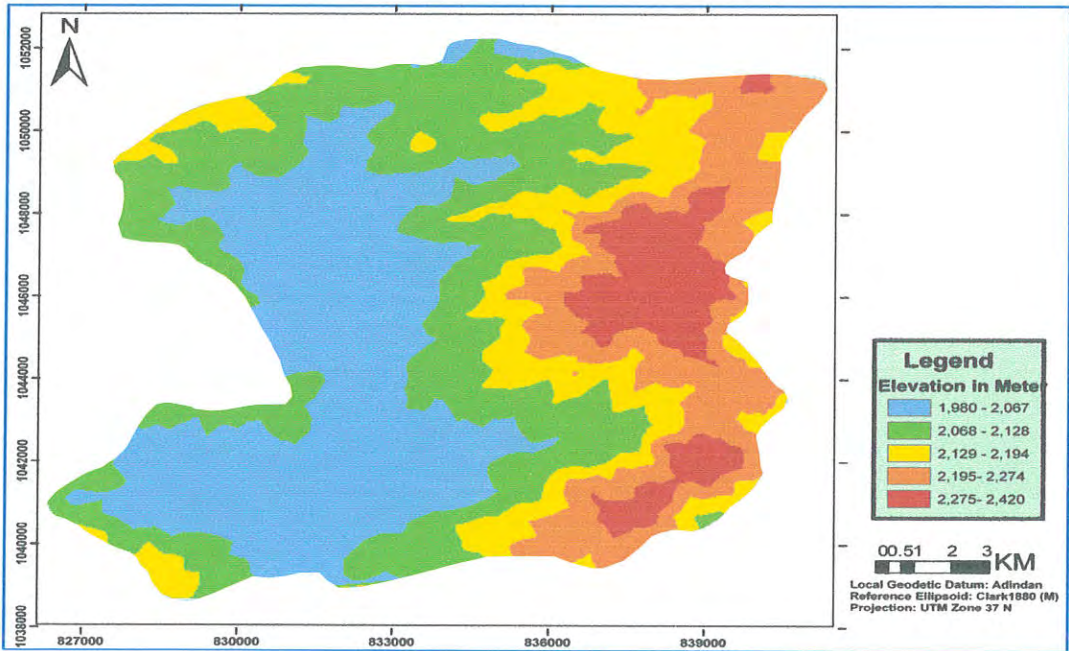
Slope Map of the Study Area

Map 11



Elevation Map of the Study Area

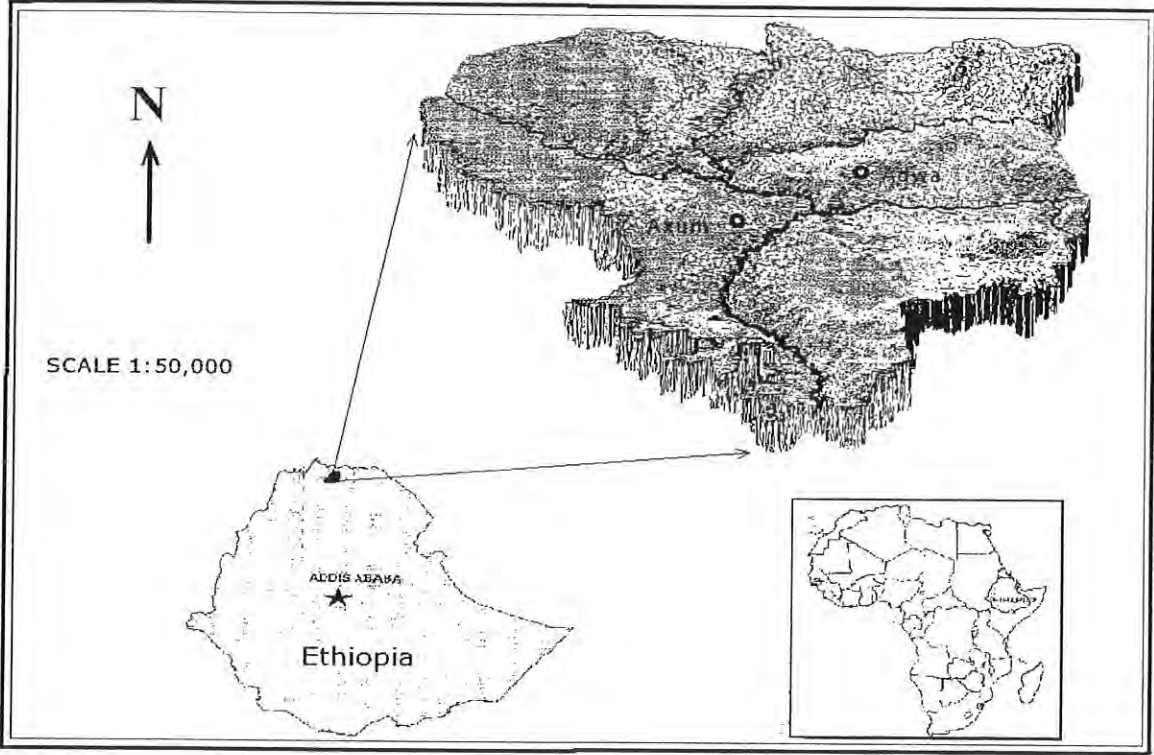
Map 12



ANNEX II

Map 1.1

Study Area Map (Physical)



Source: Ethiopian Mapping Agency (2007)

ANNEX IV

A. SURVEY QUESTIONNAIRE

Introduction

This questionnaire is prepared for an academic purpose for the fulfillment of MA Degree in Development Studies from Addis Ababa University, College of Development Studies, Department of Rural Livelihood and Development (CDS-RLD). The objective of the study is to assess/examine land-use dynamics and its implication on household livelihoods, and recommend for the possible alternative solutions and institutional arrangement(s). Your genuine response to this questionnaire is very crucial for the success of the whole study. And thus, I would like to thank you in advance for your kindly cooperation.

1. General Information

1.1 Local Identification:

Woreda Name: _____ 'Tabya' Name: _____ 'Kushet' Name: _____

1.2 Data Collector's Full Name: _____

1.3 Date of Data Collection: ____ / ____ / 2009 (____ / ____ / 2001 E.C)

1.4 Time of the Interview: Starting time _____ Finishing time _____

2. Household's Demographic Character

2.1 Household Sex: Male _____ Female _____

2.2 Age: (in completed years): _____

2.3 Marital Status: Single _____ Currently Married _____ Widowed _____
Divorced _____ Separated _____

2.4 Educational Level: Illiterate _____
(use thick mark/s) Can read and write _____
Formal education (specify grade level) _____

2.5 Number of permanent household members (including the head) _____

Before 15 years ago _____ : Male No _____ Female No _____

Currently _____ : Male No _____ Female No _____

2.6 Is your household formed within 15 years? Yes _____ No _____

3. Household Assets

3.1 Do you own land? Yes _____ No _____

3.2 If "Yes", please give the following details:-

No	Type of land owned	Size (in local unit)	
		Before 15 Years	Currently
1	Total land area		
2	Farm land		
3	Grazing land		
4	Others (if any)		

3.3 Do you own livestock? Yes _____ No _____

3.4 If "Yes", please give the following details:-

No	Type of livestock	Size (in local unit)	
		Before 15 Years	Currently
1	Oxen		
2	Cows		
3	Sheep		
4	Goats		
5	Horses		
6	Donkeys		
7	Mules		
8	Heifers		
9	Calves		

3.5 If your response to question No (3.3) is "No", why? (use thick mark/s)

Lack of grazing land _____ Lack of breeding animals _____
Livestock disease _____ Others (specify, if any) _____

3.6 Distance from market center:-

Before 15 years: Hour(s) _____ Minutes _____
Currently: Hour(s) _____ Minutes _____

3.7 Distance from main road:-

Before 15 years: Hour(s) _____ Minutes _____
Currently: Hour(s) _____ Minutes _____

3.8 Regarding the health status of your family, what changes have you observed during the last fifteen years? (use thick mark/s)

1) It was fine and now even improved _____ 2) It was fine and the same now _____
3) It was fine but not now _____ 4) It was not and it is not fine now _____

3.9 If the response to the above question (3.8) is either the 3rd or the 4th choices, why?

Lack of income for treatment _____ Lack of a nearby health center _____
Health treatment is costly _____ Others (specify, if any) _____

4. Land use/land cover Change Issues

4.1 What do you think about the trend of peoples' land holding in your area?

Increasing _____ Decreasing _____ Not changed _____

4.2 If your response to question (4.1) is "decreasing", what do you think is the reason?

Population pressure _____ Declining quality of land _____ Others (specify) _____

4.3 What has happened to the size of your land holding over the last 15 years?

Increasing _____ Decreasing _____ Not changed _____

4.4 If your response to question (4.3) is "decreasing", what do you think is the reason?

Population pressure _____ Declining quality of land _____ Others (specify) _____

4.5 How do you assess the sufficiency of your land for farming?

a) 15 years ago: Scarce _____ Sufficient _____ Excess _____
b) Currently: Scarce _____ Sufficient _____ Excess _____

4.6 Have you expanded your farming area into another area during the last fifteen years?

Yes _____ No _____

4.7 If your answer to question (4.6) is "Yes", please specify the area of expansion:

(use thick mark/s)

No	Area of expansion	Response	
		Yes	No
1	Forest land		
2	Steep slope area		
3	Grazing area		
4	Others (if any)		

4.8 If your answer to question (4.6) is "Yes", please specify your reason:

(use thick mark/s)

No	Reasons for expansion	Response	
		Yes	No
1	Land scarcity		
2	Declining land quality		
3	Natural catastrophes		
4	Others (if any)		

4.9 If your answer to question (4.6) is "Yes", is your household food secured following the farming expansion?

Yes _____ No _____

4.10 What other factors in your area have contributed to land-use/land-cover changes?

(use thick mark/s)

No	Factors for land-use/land-cover Change	Response	
		Yes	No
1	Government policy/intervention		
2	NGO/CBO intervention		
3	Local peoples' attitude to the environment		
4	Others (if any)		

4.11 How is your household affected following the land-use/land-cover changes in your area? (use thick mark)

No	Land-use/land-cover Change's Impact on HHs	Response	
		Yes	No
1	Positively		
2	Negatively		
3	Do not know		
4	Others (if any)		

4.12 How is the local environment affected with respect to land-use/land-cover changes in your area? (use thick mark/s)

No	Land-use/land-cover Change's Impact on env't	Response	
		Yes	No
1	Positively		
2	Negatively		
3	Do not know		
4	Others (if any)		

5. Livelihood Activity and Strategy

5.1 What is your main source of income?

a) 15 years ago: Only farming _____ Only livestock rearing _____
Farming and livestock _____ Others (specify, if any) _____

b) Currently: Only farming _____ Only livestock rearing _____
Farming and livestock _____ Others (specify, if any) _____

5.2 Do you practice following on your land?

a) 15 years ago: Yes _____ No _____

b) Currently: Yes _____ No _____

5.3 Which of the following mechanisms have you used to boost your agricultural output?

No	Mechanism	Time			
		15 years ago		Currently	
		Yes	No	Yes	No
1	Manure application				
2	Mulching (Compost)				
3	Fertilizers				
4	Improved seeds				
5	Herbicides				
6	Pesticides				
7	Others (if any)				

5.4 Do you practice soil conservation measures?

a) 15 years ago: Yes _____ No _____

b) Currently: Yes _____ No _____

5.5 If your answer to question 5.4 (either in 'a' or 'b' or both) is "Yes", please give the following details:

No	Type of Soil Conservation	15 years ago		Currently	
		Yes	No	Yes	No
1	Terracing				
2	Tree planting				
3	Check dams				
4	Contour ploughing				
5	Others (if any)				

5.6 If you do not practice soil conservation measures, why?

Because, I did not want to _____ Lack of income _____
Lack of labor _____ Others (specify, if any) _____

5.7 Has any member of your household migrated to other area to secure means of living?

a) 15 years ago: Yes _____ No _____

b) Recently: Yes _____ No _____

5.8 Has any member of your household participated in any activity other than farming and livestock rearing?

a) 15 years ago: Yes _____ No _____

b) Recently: Yes _____ No _____

5.9 If your answer to question 5.8 (either in 'a' or 'b' or both) is "Yes", please give information concerning the nature of work:

No	Type of activity	Work Background				How Much Earned			
		15 Yrs ago		Currently		15 yrs ago		Currently	
		Yes	No	Yes	No	Yes	No	Yes	No
1	Trading livestock								
2	Trading grains								
3	Selling fuel wood								
4	Daily laborer								
5	Weaving								
6	Carpentry								
7	Pottery								
8	Petty trade								
9	Others (if any)								

5.10 If your answer to question number (5.8) is "No", why?

Because, No employment opportunity _____ Low wage of work _____
Place where work is available is far _____ To concentrate on farming _____
Other reasons (specify, if any) _____

5.11 Please give information concerning your nature of work: (use thick mark/s)

No	Type of activity	Work Background				How Much Earned			
		15 Yrs ago		Currently		15 yrs ago		Currently	
		Yes	No	Yes	No	Yes	No	Yes	No
1	Trading livestock								
2	Trading grains								
3	Selling fuel wood								

4	Daily laborer								
5	Weaving								
6	Carpentry								
7	Pottery								
8	Petty trade								
9	Others (if any)								

5.12 Please give information for the following details concerning your farm products.

No	Farm Product	Area Cultivated (<i>local unit</i>)		Amount Produced (<i>local unit</i>)	
		15 yrs ago	Currently	15 yrs ago	Currently
1	<i>Teff</i>				
2	Barley				
3	Maize				
4	Wheat				
5	Pea				
6	Bean				
7	Sorghum				
8	Oil seeds				
9	Others (if any)				

6. Food Security Issues

6.1 Do you meet the all-year round food requirements of your household members from own production? (*use thick mark*) Yes _____ No _____

6.2 If you are not self sufficient, for how many months do your own productions cover the food requirements at home? (may mention months) _____

6.3 Does the income you earn from non-farm activities enable you to buy food for bridging the deficiency? (*use thick mark*) Yes _____ No _____

6.4 How would you assess your household in terms of food security?

Food secure _____

Food insecure _____

Varies from one year to another _____ Do not know _____

6.5 When you face crop failures and/or your output is not sufficient to fulfill your needs, which of the following coping mechanisms have you used to overcome the problem?

No	Copping Mechanism	15 years ago		Currently	
		Yes	No	Yes	No
1	Selling Oxen				
2	Selling other livestock				
3	Selling other household properties				
4	Daily labor				
5	Borrowing money or grain				
6	Fuel wood/Charcoal selling				

7	Reducing amount of meals				
8	Assistance				
9	Migration to other areas				
10	Others (specify)				

6.6 If your answer is "Food Insecure", what do you think are the main reasons?
(use thick mark/s)

Reason for Food Insecurity	Yes	No
Inability to produce sufficient grains and to rear livestock		
Meager income from non-farm activities		
Instability due to frequent changes in rural policies		
Failure to properly utilize own production and other earning		
Others (if any)		

6.7 If your answer is "Food Insecure", do you think that it is related to land-use change in your area? Yes _____ No _____

6.8 What have been the main constraints to expanding your crop production, as well as for keeping sufficient numbers of stock in order to become self-sufficient in food year round? (use thick mark/s)

6.8.1 Constraints to crop production (use thick mark)

No	Constraints	Yes	No	3rd most important bottleneck
1	Drought			
2	Frost			
3	Water logging			
4	Pests and disease			
5	Erratic rainfall distribution			
6	Weeds			
7	Shortage/lack of farm oxen			
8	Poor storage			
9	Insufficient land holding			
10	Poor soil fertility			
11	Lack of access to appropriate technology			
12	Limited know-how and skills			
13	Shortage of life			
14	Inadequate extension services			
15	Inability to apply sufficient modern farm inputs			
16	Dependency on rain-fed farming			
17	Failure to utilize irrigation			
18	Lack of access to post-harvest technology			
19	Others (Specify, if any)			

6.8.2. Constraints to livestock rearing (use thick mark/s)

No	Constraints	Yes	No	3rd most important
----	-------------	-----	----	--------------------

				bottleneck
1	Lack of sufficient grazing lands and fodder			
2	Stock disease			
3	Poor stock disease			
4	Traditional attitude towards large numbers			
5	Failure to properly use stock products			
6	Lack of markets for stock products			
7	Lack of access to better stock breeds			
8	Others (Specify, if any)			

6.9 Rural interventions and rural policy changes that have had significant impact on household food security.

No	Constraints	Yes	No	3rd most important bottleneck
1	Lack of land tenure security			
2	Displacement by cooperatives, villagization and resettlement			
3	Frequent rural policy changes			
4	High turn over of local administrators			
5	Unstable prices for agricultural commodities			
6	Others (Specify, if any)			

6.10 Reasons for lack of sufficient and viable income from non-farm activities to become food secure at household. *(use thick mark/s)*

No	Reasons	Yes	No	3rd most important bottleneck
1	Lack of land tenure			
2	Displacement by cooperatives, villagization and resettlement			
3	Frequent rural policy changes			
4	Cast: lack of respect for some activities			
5	Unable to work (disability)			
6	Lack of raw materials and working			
7	Lack of market			
8	Poor infrastructure to support activities			
9	Absence of rural credit			
10	Others (Specify, if any)			

6.11 Household coping strategy to food insecurity and survival strategies
(use thick mark/s)

No	Coping Strategy	Yes	No	3rd most important bottleneck
1	Livestock dispersal or de-stocking			
2	Change of cropping patterns			
3	Migration to nearby towns for wage labor			
4	Consuming famine period or less preferred food			
5	Borrow grains/cash from lenders			
6	Migrate to other rural area for wage labor			
7	Sell off small animals			
8	Firewood and charcoal selling			
9	Rely on relief of small grains			
10	Sell off farm oxen			
11	Lease out land			
12	Sell off land			
13	Desperate migration			
14	Others (Specify, if any)			

Thank You for your Time !

ANNEX V

(Tigrinya Version of the Questionnaire)

ቃለ - መሕትት

መጻተዊ

ዕላማ እዚ ቃለ-መሕትት እዚ ብመንገዲ ሳይንሳዊ ምርምር ኣቢሉ ሓዱሽ ፍልጠት ኣብ ምርካብ ዘትኩርን ካብ ዮኒቨርሲቲ ኣዲስ ኣበባ ክፍሊ ትምህርቲ መፅናዕቲ ልምዓት ሃገር (College of Development Studies) ንዝርከብ ካልኣይ ዲግሪ (Masters Degree) ንመዓላ መማልኢ መፅናዕታዊ ዕሑፍ ዝኸውን ሓበሬታ ንምእካብ እዮ። ንዝቐርብሎም ሕቶታት ቅነዕ መልሲ ምሃቦም ዕላማ ናይዚ መፅናዕቲ እዚ ሽቱኡ ክወቅዕ ዓብይ ተራ ኣለዎ። ስለቲ ግዜኡም ሰዊኦም ብቐንዕና ንሕቶታተይ መልሲ ብምሃብ ዝተሓባበሩኒ ኣቐዲመ ከመስግን ይፎቱ።

1. ሓፈሻዊ ሓበሬታ

1.1 ክባቢያዊ ሓበሬታ

ሽም ወረዳ: _____ ሽም ጣብያ: _____ ሽም ቁሽት: _____

1.2 ሽም ኣካቢ ሓበሬታ

1.3 ሓበሬታ ዝተኣከበሉ ዕለት _____ / _____ / 2001 ዓ.ም

1.4 ቃለ-መሕትት ዝተገብረሉ ግዜ: ዝተጀመረሉ ሰዓት _____ ዝተዛዘመሉ ሰዓት _____

2. ስነ-ህዝባዊ ሓበሬታ መራሕቲ ስድራ

2.1 ፆታ መራሕ. ስድራ: ተባዕታይ _____ ኣንስተይቲ _____

2.2 ዕድመ (ብምሉእ ዓመታት ይፅሓፉ) _____

2.3 ኩነታት ናብራ: ናብ ሰብ ዘይተሓውሰ/ት _____ ዝመሰለ/ት _____
በዓል ቤቱ/ታ ዝሞተቶ/ታ _____ ዝተፋተሐ/ት _____ ዝተፈላለየ/ት _____

2.4 ደረጃ ትምህርቲ: ፊደል ዘይቐፀረ _____ ምዕሓፍን ምንባብን ዝመለኸ _____
ኣካዳምያዊ ትምህርቲ ዝቐሰመ (ደረጃ ትምህርቲ ይጠቐስ) _____

2.5 ቁፅሪ ኣባላት ስድራ (እንተላይ ንቲ መራሕ. ስድራ ሓዊስካ) _____
ቅድሚ 15 ዓመታት _____ : ቁፅሪ ደቂ-ተባዕትዮ _____ ቁፅሪ ደቂ-ኣንስትዮ _____
ኣብዚ እዋን እዚ _____ : ቁፅሪ ደቂ-ተባዕትዮ _____ ቁፅሪ ደቂ-ኣንስትዮ _____

2.6 ስድረኡም እዋን ጎጆ ዝወፀተሉ ኣብ ውሽጢ 15 ዓመታት ዶ ነይሩ?
እወ _____ ኣይፋል _____

3. ሓበሬታ ኩነታት ጥሪት መራሕቲ ስድራ

3.1 ወናኒ መሬት ድዮም? እወ _____ ኣይፋል _____

3.2 መልሶም "እወ" ዝብል እንተ'ኾይኑ፤ ንዞም ዝስዕቡ ነጥብታት ዝምልከት ሓበሬታ ይሃቡ:-

(ፊት፡ቂ ቅጥ፡ዕ መልሱን ዝብልዎ ምልክት ሕገዓፅ የቐምጡ)

ቁፅሪ	ኩነታት ዝውነን መሬት	መጠን ዝውነን መሬት	
		ቅድሚ 15 ዓመታት	ኣብዚ እዋን እዚ
1	ዓቕን ስፍሓት መሬት		
2	ዝሕረስ መሬት		
3	መገሃጫ መሬት		
4	ካልእ ዘይተጠቐሰ 'ተልዩ		

- 3.3 ጥሪት (እንስሳታት) ኣለውዎም ዶ? እወ _____ ኣይፋል _____
- 3.4 መልሶም "እወ" ዝብል እንተድኣ ኾይኑ፤ ንዞም ዝስዕቡ ነጥባታት ዝምልከት ሓበሬታ ይሃቡ፡-

(ፊት፡ቂ ቅጥ፡ዕ መልሱን ዝብልዎ ምልክት ሕገዓፅ የቐምጡ)

ቁፅሪ	ዓ ይነት ዝውነን ጥሪት	ኩነታት ዝውነን ጥሪት	
		ቅድሚ 15 ዓመታት	ኣብዚ እዋን እዚ
1	ኣብዑር (ብዕራይ)		
2	ኣላሕም (ላሕሚ)		
3	ኣባጊዕ		
4	ኣጣል		
5	ኣፍራስ (ፈረስ)		
6	ኣብቃል (በቐሊ)		
7	ኣእዱግ (ኣድጊ)		
8	ምራኽቲ (ምራኽ)		
9	ካልእ ዘይተጠቐሰ 'ተልዩ		

- 3.5 ንሕቶ ቁፅሪ 3.4 ዝሃብዎ መልሲ "ኣይፋል" ዝብል እንተድኣ ኾይኑ፤ ስለምንታይ? ብሰንኪ ስእነት መገሃጫ መሬት _____ ብሰንኪ ስእነት ማእኸል መዳቐሊ እንስሳ _____ ብሰንኪ ሕማም ጥሪት (እንስሳ) _____ ካልእ ዘይተጠቐሰ ጠንቂ 'ተልዩ _____ ::

- 3.6 ርሕቐት ካብ ገዝኡም ናብ ማእኸል ዕዳጋ፡-

ቅድሚ 15 ዓመታት፡ ሰዓት/ታት _____ ደቓይቕ _____
 ኣብዚ እዋን እዚ፡ ሰዓት/ታት _____ ደቓይቕ _____

- 3.7 ማእኸላይ ርሕቐት ካብ ገዝኡም ናብ ዋና መንገዱ፡-

ቅድሚ 15 ዓመታት፡ ሰዓት/ታት _____ ደቓይቕ _____
 ኣብዚ እዋን እዚ፡ ሰዓት/ታት _____ ደቓይቕ _____

- 3.8 ኩነታት ጥዕና ስድርኦም ብዝምልከት ኣብ ዝሓለፉ 15 ዓመታት እንታይ ዝተዓዘብዎ ወይ ዝረኣይዎ ለውጢ ኣሎ?

- 1) ፅቡቕ'ዩ ነይሩ ሕዚ ድማ ተመሓይሹ _____ 2) ፅቡቕ'ዩ ነይሩ ሕዚ 'ውን ከምኡ _____
 3) ፅቡቕ'ዩ ነይሩ ሕዚ ግን ከምኡ የለን _____ 4) ፅቡቕ ኣይነበረን ሕዚ 'ውን የለን _____

- 3.9 ንሕቶ ቁፅሪ 3.8 ዝሃብዎ መልሲ '3ይ' ወይ '4ይ' ዝብል እንተድኣ ኾይኑ፤ ስለምንታይ? ብሰንኪ ስእነት መኽፈሊ ወፃኢታት ሕክምና _____ ብሰንኪ ስእነት ግልጋሎት ጥዕና _____ ወፃኢታት ሕክምና ክባር 'ዩ _____ ካልእ ዘይተጠቐሰ ጠንቂ 'ተልዩ _____ ::

4. ንኹነታት ለውጢ አጠቃቅማ መሬት/ሽፋን መሬት ዝምልከት ሓበሬታ

4.1 ንኹነታት ትሕዝቶ መሬት ሕብረተሰብ ከባቢኦም አመልኪቶም 'ታይ ርእይቶ' ስዎም? ትሕዝቶ መሬት፡-

ይውስኽ 'ሎ _____ ይቕንስ 'ሎ _____ ለውጢ የብሉን _____

4.2 ንሕቶ ቁፅሪ 4.1 ዝሃብዎ መልሲ 'ይቕንስ ኣሎ' ዝብል እንተድኣ ኾይኑ፤ ስለምንታይ? ጸቕጢ በዝሒ ህዝቢ _____ ምቕናስ ልመዕነት መሬት _____ ካልእ ዘይተጠቐሰ ጠንቂ 'ተልዩ _____ ::

4.3 ስፍሓት ዝሕረስ መሬት ስድራኹም ኣብ ዝሓለፉ 15 ዓመታት 'ታይ ይመስል? ይውስኽ 'ሎ _____ ይቕንስ 'ሎ _____ ለውጢ የብሉን _____

4.4 ንሕቶ ቁፅሪ 4.3 ዝሃብዎ መልሲ 'ይቕንስ ኣሎ' ዝብል እንተድኣ ኾይኑ፤ ስለምንታይ? ጸቕጢ በዝሒ ህዝቢ _____ ምቕናስ ልመዕነት መሬት _____ ካልእ ዘይተጠቐሰ ጠንቂ 'ተልዩ _____ ::

4.5 መጠንን እኹልነትን ዝሕረስ መሬት ስድራኹም ከመይ ትምዝንዎ? ቅድሚ 15 ዓመታት፡ ዘይእኹል _____ እኹል _____ ኣኺሉ ትሩፍ _____ ኣብዚ እዋን እዚ፡ ዘይእኹል _____ እኹል _____ ኣኺሉ ትሩፍ _____

4.6 መጠን ዝሕረስ መሬት ስድራኹም ኣብ ዝሓለፉ 15 ዓመታት ኣግፊሕኻዎ ዶ? እወ _____ ኣይፋል _____

4.7 ንሕቶ ቁፅሪ 4.6 ዝሃብዎ መልሲ "እወ" ዝብል እንተድኣ ኾይኑ፤ ናብ ምንታይ ከባቢ ከምዘግፍሕዎ ይሓብሩ? (ፊት'ቲ ቅንፅ መልሲ'ዩ ዝብልዎ ምልክት ሕንፃፅ የቐምጡ)

ቁፅሪ	ዝገፍሓሉ ከባቢ	መልሲ	
		እወ	ኣይፋል
1	ናብ ሕዙእ (ብኣግራብ ዝተሸፈነ) መሬት		
2	ናብ ሓውሲ ኣፃድፍ ቁልቁል መሬት		
3	ናብ መገሃጫ መሬት ጥሪት		
4	ካልእ ዘይተጠቐሰ 'ተልዩ		

4.8 ንሕቶ ቁፅሪ 4.7 ዝሃብዎ መልሲ 'እወ' ዝብል እንተድኣ ኾይኑ፤ 'ቲ ምክንያት 'ዩ? (ፊት'ቲ ቅንፅ መልሲ'ዩ ዝብልዎ ምልክት ሕንፃፅ የቐምጡ)

ቁፅሪ	ምክንያት ምግፋሕ ዝሕረስ መሬት	መልሲ	
		እወ	ኣይፋል
1	ሕፅረት ዝሕረስ መሬት		
2	ምንካይ ልመዕነት መሬት		
3	መኻልፍ ተፎጥሮአዊ ሓደጋታት		
4	ካልእ ዘይተጠቐሰ 'ተልዩ		

4.9 ንሕቶ ቁፅሪ 4.8 ካብ ዝሃብዎ መልሲ “እወ” ዝብል እንተድኣ ዝርከበ ኾይኑ፤ ዝዘከርኩሱ ኩነት ዝከሰተ ወሕስነት መግቢ ስድረኦም ኣረጋጊፆም ዶ? እወ _____ ኣይፋል _____

4.10 ካብዞም ዝስዕቡ ንለውጢ ኣጠቓቕማ መሬት/ሽፋን መሬት ዝድርኹ ረጅሕታት ንቶም ኣብ ከባቢኹም ዝረኣዩ ፍለዩ፡-

(ፊት'ቲ ቅኑሶ መልሲ'ዩ ዝብልዎ ምልክት ሕንፃዕ የቐምጡ)

ቁፅሪ	ረጅሕታት ለውጢ ኣጠቓቕማ መሬት/ሽፋን መሬት	መልሲ	
		እወ	ኣይፋል
1	ምትእትታው ፖሊሲታት መንግስቲ		
2	ምትእትታው ስራሕቲ ገበርቲ ሰናይ		
3	ኣራእያ ሕ/ሰብ'ቲ ኸባቢ ኣብ ልዕሊ'ቲ ስነ-ከባቢ		
4	ካልእ ዘይተጠቐሰ 'ተልዩ		

4.11 ንለውጢ ኣጠቓቕማ መሬት/ሽፋን መሬት ስዲቡ ኩነታት መነባብሮ ስድረኦም ብኸመይ መልክዕ ተፀልዩ?

(ፊት'ቲ ቅኑሶ መልሲ'ዩ ዝብልዎ ምልክት ሕንፃዕ የቐምጡ)

ቁፅሪ	ፅልዋ ለውጢ ኣጠቓቕማ መሬት/ሽፋን መሬት ኣብ ልዕሊ መራሕቲ ስድራ	መልሲ	
		እወ	ኣይፋል
1	እወንታዊ		
2	ኣሉታዊ		
3	ኣይፈልጥን (ርግፀኛ ኣይኮንኩን)		
4	ካልእ ዘይተጠቐሰ 'ተልዩ		

4.12 ብምኽንያት ለውጢ ኣጠቓቕማ መሬት/ሽፋን መሬት'ቲ ስነ-ከባቢ ብኸመይ መልክዕ ተፀልዩ?

(ፊት'ቲ ቅኑሶ መልሲ'ዩ ዝብልዎ ምልክት ሕንፃዕ የቐምጡ)

ቁፅሪ	ፅልዋ ለውጢ ኣጠቓቕማ መሬት/ሽፋን መሬት ኣብ ልዕሊ ስነ-ከባቢ	መልሲ	
		እወ	ኣይፋል
1	እወንታዊ		
2	ኣሉታዊ		
3	ኣይፈልጥን (ርግፀኛ ኣይኮንኩን)		
4	ካልእ ዘይተጠቐሰ 'ተልዩ		

5. ኩነታት መነባብሮን ስልቲታትን መራሕቲ ስድራ

5.1 ዋና ምንጪ እቶቶም እንታይ 'ዩ?

ሀ) ቅድሚ 15 ዓመታት፡ ሕርሻ ጥራሕ _____ መጓሰ ጥራሕ _____
 ሕርሻን መጓሰን _____ ካልእ ዘይተጠቐሰ 'ተልዩ

::

ለ) ኣብዚ እዋን እዚ፡ ሕርሻ ጥራሕ _____ መጓሰ ጥራሕ _____
 ሕርሻን መጓሰን _____ ካልእ ዘይተጠቐሰ 'ተልዩ

::

5.6 If you do not practice soil conservation measures, why?

Because, I did not want to _____ Lack of income _____
Lack of labor _____ Others (specify, if any) _____

5.7 Has any member of your household migrated to other area to secure means of living?

a) 15 years ago: Yes _____ No _____

b) Recently: Yes _____ No _____

5.8 Has any member of your household participated in any activity other than farming and livestock rearing?

a) 15 years ago: Yes _____ No _____

b) Recently: Yes _____ No _____

5.9 If your answer to question 5.8 (either in 'a' or 'b' or both) is "Yes", please give information concerning the nature of work:

No	Type of activity	Work Background				How Much Earned			
		15 Yrs ago		Currently		15 yrs ago		Currently	
		Yes	No	Yes	No	Yes	No	Yes	No
1	Trading livestock								
2	Trading grains								
3	Selling fuel wood								
4	Daily laborer								
5	Weaving								
6	Carpentry								
7	Pottery								
8	Petty trade								
9	Others (if any)								

5.10 If your answer to question number (5.8) is "No", why?

Because, No employment opportunity _____ Low wage of work _____
Place where work is available is far _____ To concentrate on farming _____
Other reasons (specify, if any) _____

5.11 Please give information concerning your nature of work: (use thick mark/s)

No	Type of activity	Work Background				How Much Earned			
		15 Yrs ago		Currently		15 yrs ago		Currently	
		Yes	No	Yes	No	Yes	No	Yes	No
1	Trading livestock								
2	Trading grains								
3	Selling fuel wood								

4	Daily laborer								
5	Weaving								
6	Carpentry								
7	Pottery								
8	Petty trade								
9	Others (if any)								

5.12 Please give information for the following details concerning your farm products.

No	Farm Product	Area Cultivated (<i>local unit</i>)		Amount Produced (<i>local unit</i>)	
		15 yrs ago	Currently	15 yrs ago	Currently
1	<i>Teff</i>				
2	Barley				
3	Maize				
4	Wheat				
5	Pea				
6	Bean				
7	Sorghum				
8	Oil seeds				
9	Others (if any)				

6. Food Security Issues

6.1 Do you meet the all-year round food requirements of your household members from own production? (*use thick mark*) Yes _____ No _____

6.2 If you are not self sufficient, for how many months do your own productions cover the food requirements at home? (may mention months) _____

6.3 Does the income you earn from non-farm activities enable you to buy food for bridging the deficiency? (*use thick mark*) Yes _____ No _____

6.4 How would you assess your household in terms of food security?

Food secure _____

Food insecure _____

Varies from one year to another _____ Do not know _____

6.5 When you face crop failures and/or your output is not sufficient to fulfill your needs, which of the following coping mechanisms have you used to overcome the problem?

No	Coping Mechanism	15 years ago		Currently	
		Yes	No	Yes	No
1	Selling Oxen				
2	Selling other livestock				
3	Selling other household properties				
4	Daily labor				
5	Borrowing money or grain				
6	Fuel wood/Charcoal selling				

7	Reducing amount of meals				
8	Assistance				
9	Migration to other areas				
10	Others (specify)				

6.6 If your answer is “Food Insecure”, what do you think are the main reasons?

(use thick mark/s)

Reason for Food Insecurity	Yes	No
Inability to produce sufficient grains and to rear livestock		
Meager income from non-farm activities		
Instability due to frequent changes in rural policies		
Failure to properly utilize own production and other earning		
Others (if any)		

6.7 If your answer is “Food Insecure”, do you think that it is related to land-use change in your area? Yes _____ No _____

6.8 What have been the main constraints to expanding your crop production, as well as for keeping sufficient numbers of stock in order to become self-sufficient in food year round? (use thick mark/s)

6.8.1 Constraints to crop production (use thick mark)

No	Constraints	Yes	No	3rd most important bottleneck
1	Drought			
2	Frost			
3	Water logging			
4	Pests and disease			
5	Erratic rainfall distribution			
6	Weeds			
7	Shortage/lack of farm oxen			
8	Poor storage			
9	Insufficient land holding			
10	Poor soil fertility			
11	Lack of access to appropriate technology			
12	Limited know-how and skills			
13	Shortage of life			
14	Inadequate extension services			
15	Inability to apply sufficient modern farm inputs			
16	Dependency on rain-fed farming			
17	Failure to utilize irrigation			
18	Lack of access to post-harvest technology			
19	Others (Specify, if any)			

6.8.2 Constraints to livestock rearing (use thick mark/s)

No	Constraints	Yes	No	3rd most important
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				bottleneck
1	Lack of sufficient grazing lands and fodder			
2	Stock disease			
3	Poor stock disease			
4	Traditional attitude towards large numbers			
5	Failure to properly use stock products			
6	Lack of markets for stock products			
7	Lack of access to better stock breeds			
8	Others (Specify, if any)			

6.9 Rural interventions and rural policy changes that have had significant impact on household food security.

No	Constraints	Yes	No	3rd most important bottleneck
1	Lack of land tenure security			
2	Displacement by cooperatives, villagization and resettlement			
3	Frequent rural policy changes			
4	High turn over of local administrators			
5	Unstable prices for agricultural commodities			
6	Others (Specify, if any)			

6.10 Reasons for lack of sufficient and viable income from non-farm activities to become food secure at household. (*use thick mark/s*)

No	Reasons	Yes	No	3rd most important bottleneck
1	Lack of land tenure			
2	Displacement by cooperatives, villagization and resettlement			
3	Frequent rural policy changes			
4	Cast: lack of respect for some activities			
5	Unable to work (disability)			
6	Lack of raw materials and working			
7	Lack of market			
8	Poor infrastructure to support activities			
9	Absence of rural credit			
10	Others (Specify, if any)			

6.11 Household coping strategy to food insecurity and survival strategies
(use thick mark/s)

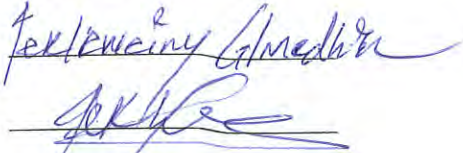
No	Coping Strategy	Yes	No	3rd most important bottleneck
1	Livestock dispersal or de-stocking			
2	Change of cropping patterns			
3	Migration to nearby towns for wage labor			
4	Consuming famine period or less preferred food			
5	Borrow grains/cash from lenders			
6	Migrate to other rural area for wage labor			
7	Sell off small animals			
8	Firewood and charcoal selling			
9	Rely on relief of small grains			
10	Sell off farm oxen			
11	Lease out land			
12	Sell off land			
13	Desperate migration			
14	Others (Specify, if any)			

Thank You for your Time !

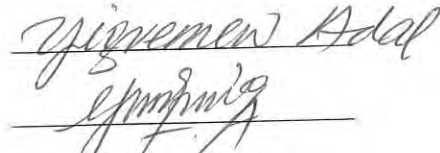
Declaration

I, the undersigned, declare that the thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Declared by:


Candidate

Confirmed by:


Advisor