**ADDIS ABABA UNIVERSITY**
**SCHOOL OF GRADUATE STUDIES**

# LINKING INDIGENOUS WITH 'CONVENTIONAL' MEASURES FOR SUSTAIANBLE LAND MANAGEMENT IN THE HIGHLANDS OF ETHIOPIA: A CASE STUDY OF DIGIL WATERSHED, EAST GOJJAM

BY
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**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN GEOGRPHY**

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# Linking Indigenous with the 'Conventional' Measures for Sustainable Land Management in the Highlands of Ethiopia: A case study of Digil Watershed, East Gojjam

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## Acknowledgement

This study has benefited from the contributions of many individuals. I am most indebted to my thesis advisor Prof. Belay Tegene for his guidance, constructive comments, and encouragement throughout the course of my work. His valuable advice has helped me realize the thesis. I would also like to thank Woldeamlak Bewket who gave me an extensive assistance of various types during the field survey.

My sincere thanks also go to all staff members of the Department of Geography for their invaluable assistance and encouragement. I am very grateful to Ato Esayas Sahlu and Ato Yirgalem Mahiteme who did the tedious work of digitizing the map and producing the final maps included in the thesis.

My sincere thanks also go to all my friends, particularly Bekele Getahun, Desalegn Wana, Mitiku Desta, Teferi Mekonnen and Habtamu Hika, for their invaluable assistance and encouragement. I would finally like to extend my sincere appreciation to all the farmers' in and around the study area, the Gozamen WoA staffs, my field assistants, and Ato Wassihun, driver in School of Graduate Studies.

Last but not least, I would like to express my sincere gratitude to the German Academic Exchange Services (DAAD) for its financial support throughout the course of my study.

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## Abstract

This paper attempts to explore the ways of linking indigenous with 'conventional' measures for achieving sustainable land management in the highlands of Ethiopia in general and the northwestern highlands in particular. A representative highland watershed, the Digil Watershed of East Gijjam, was selected for the study. The watershed is typical of the high-potential, intensively cultivated, mixed farming, ox-plough cereal belt in the northwestern Ethiopian highlands. The socio-economic as well as the demographic data that have relevance to the study were collected and both the indigenous and the 'conventional' land management practices were explored using questionnaire surveys, focus group discussions, and key informant interview. About 60 farmers were interviewed in the selected watershed. Topsoil depth and slope data were collected from 60 randomly selected farm plots using auger and clinometer, receptively, to classify the observed plots into erosion risk classes based on a revised Treatment-Oriented Land Capability Classification Scheme.

Pool of indigenous land management practices were/are practiced by farmers of the study watershed. The mesures are well adapted to local conditions and widely practiced by farmers. Two types of indigenous land management practices have been observed. The household-level land management practices such as traditional ditches (feses), cropping, weed heaping, etc, which are practiced and/or managed by single household, and both protection as well as production oriented. Other indigenous land management practices such as traditional waterways, traditional cutoff drain, etc. are supra-household level (neighborhood-level and community-level) and more of protection oriented. Multi-functionality, flexibility, low external input requirement, complimentarity, compatibility to the prevailing farming system etc., are found to be the strengths of these land management practices.

On the other hand, the 'conventional' measures that are currently introduced into the study watershed are the fanya juu bunds, checkdams, and artificial waterways among the soil conservation measures, and artificial fertilizers among the fertility enhancing measures. The soil conservation measures are found to be less flexible, space taking, and incompatible to the farming system, labour intensive and high external input dependent. Regarding, the artificial fertilizers high price, lack of credit, and untimely supply are found tobe the major constraints.

Generally, in order to link these measures the factors that affect farmers' decision to invest on land management activities as well as their decision on the choice of land management measures should be explored. From the study it has been found that farmers decision to invest on land management activities and their choice of land management mesures are affected [positively or negatively] by several factors. These include land related factors: land holding size, land fragmentation, land ownership security; size of livestock; labour availability; production assets availability etc. In addition, the merits and demerits of both [indigenous and 'conventional'] measures should be assessed. And then, by taking a lesson from their merits, the measures can be purposefully complimented in order to meet the desired objective.

# CHAPTER-I
# INTRODUCTION

## *1.1 Statement of the problem*

Producing more food to feed the rapidly rising world population, while maintaining and/or conserving the environment, has become a global challenge (Dumaniski 1997; Ambler 2000). The rural poor are heavily dependent upon natural resources particularly land to sustain their livelihoods. Hence, attacking poverty in rural areas is believed to be a matter of improving poor people's ability to derive sustenance and income from more productively and sustainably managed land resources (Ambler 2000). This is particularly true in developing countries like Ethiopia where agriculture is the backbone of the economy, and the main source of food, industrial raw materials and foreign exchange earnings.

As agriculture is the prime mover of the country's economy, the current development strategy in Ethiopia, known as Agricultural Development Led Industrialization (ADLI), is largely based on expanding agricultural production. However, the performance of the sector has remained weak. One of the consequences of the poor performance of the sector is widespread food insecurity problem. Currently, an estimated 50 to 60% of the country's population is food insecure or live below the poverty line (Mulat Demeke 1999). Several factors are hypothesized as underlying causes of this problem. But land degradation in the form of soil erosion and soil fertility decline in the agricultural lands of the highland parts of the country is believed to be the major cause of the problem.

Ethiopia is one of the sub-Saharan African countries where degradation of the soil largely impedes socioeconomic development. Currently, soil related problems are confronting the agricultural sector, which is mainly characterized by its subsistence nature (Belay Tegene 2000b; Gete Zeleke 2000). In some areas the land degradation resulting from soil erosion and soil fertility decline are much faster than they can be replaced (Belay Tegene 1998a;Pender et al 2000). Some reports reveal that about a quarter of the highlands is seriously eroded, and from this nearly 4% of the total highlands are so seriously affected that they will not be economically productive in the near future (Esayas Dagnew 2000). Soil erosion by water erosion and tillage erosion are by far the most widespread forms of soil erosion, and are severely damaging agricultural production (Belay Tegene 1998a;Esayas Dagnew 2000;Woldeamlak Bewket 2001). Therefore, the problem demands sound and sustainable solutions.

Agriculture in the northwestern part of Ethiopia is characterized by a subsistence rainfed production system with simple traditional methods of production which is dominated by the ox-plough. The farming system is also characterized by cereal production, which accounts for about 73% of the cultivable area. Though these highlands contribute the highest proportion of agricultural products [cereal crops] to the rest of the country, the agricultural lands are currently under heavy stress due to land degradation. It is argued that in some parts of the region the problem has reached at an irreversible stage (Gete Zeleke 2000). And hence, sustaining the region's potential through sustainable land management is a crucial step that should be undertaken in order to secure the food supply of the Region in particular and the country in general. This is because the sustainability of the livelihood and improvement of the quality of life of people of the region and the country at large are dependent on increased production from land resources. Therefore, land resources continue to be of prime importance.

So far different attempts have been made to manage the land resource in the country through afforestation, terracing, water harvesting and area closure. However, none of them is reported to be successful in alleviating the problem (Daniel Gamachu, 1999; Wood 1990; Esayas

Dagnew 2000; Woldeamlak Bewket 2001). The reasons for the failure of past efforts are discussed as the top-down approach, the coercive nature of the intervention style, and neglect of Indigenous knowledge (IK) of farmers' in the planning, designing and implementation of land management strategies.

Currently, there is an urgent need of action as well as a new style of intervention to get sound and lasting solutions for the problem. This intervention style should be based on holistic, watershed-based land management practices involving a participatory process in planning, designing and implementation of land management measures (Reij et al 1996; De Jagar et al 1999; Scherr and Hazell 1994). In this approach, due emphasis is given for Indigenous knowledge and practices of the land users. Integrating the Indigenous knowledge and practices of land users with newly introduced ['conventional'] technologies will promote the sustainability of 'conventional' land management practices (Reij et al 1996; Lakew Desta 2000; Belay Tegene 2000b).

Therefore, this paper is designed to explore the possible ways of linking the indigenous with the 'conventional' measures for achieving sustainable land management in the north-western highlands in general and the study watershed in particular. The paper is based on the argument that the failure of past land management practices is due to the neglect of the farmers' indigenous knowledge and practices in the process of planning, designing and implementation of land management practices. Sustainable land management in the future is achieved if indigenous knowledge and practices are seriously taken into account and linked with 'conventional' ones. This is because basing 'conventional' measures on indigenous knowledge and practices will give a sustainable solution for the problem.

### *1.2. Objectives of the Study*

The general objective of this study is to explore the ways/mechanisms of achieving sustainable land management in the highlands of Ethiopia through linking indigenous with 'conventional' land management measures. The specific objectives include;

1. To understand and describe the farmers indigenous knowledge of their land, the action they take voluntarily for the management of this resource.
2. To assess the 'conventional' land management measures that are practiced in the study watershed.
3. To investigate the complimentarity of the indigenous and 'conventional' measures, and determine whether there are missing links between these measures.
4. To recommend some sound and sustainable solutions, and policy implications for sustainable land management in the highlands of the country based on the findings of the study.

### *1.3. Basic Research Questions.*

This study attempts to answer the following basic research questions;

1. What types of indigenous land management activities were/are practiced by farmers' in the study watershed? What are their strengths and/or weaknesses?
2. Which 'conventional' land management measures are practiced in the study watershed? What are their strengths and/or limitations?
3. What factors affect farmers' decision to invest on land management as well as their choice of land management practices?

4. Are there any ways/mechanisms of linking the indigenous management practices with the 'conventional' ones? What should be done to purposefully complement these two measures for achieving sustainable land management in the foreseeable future?

### *1.4. Significance of the Study*

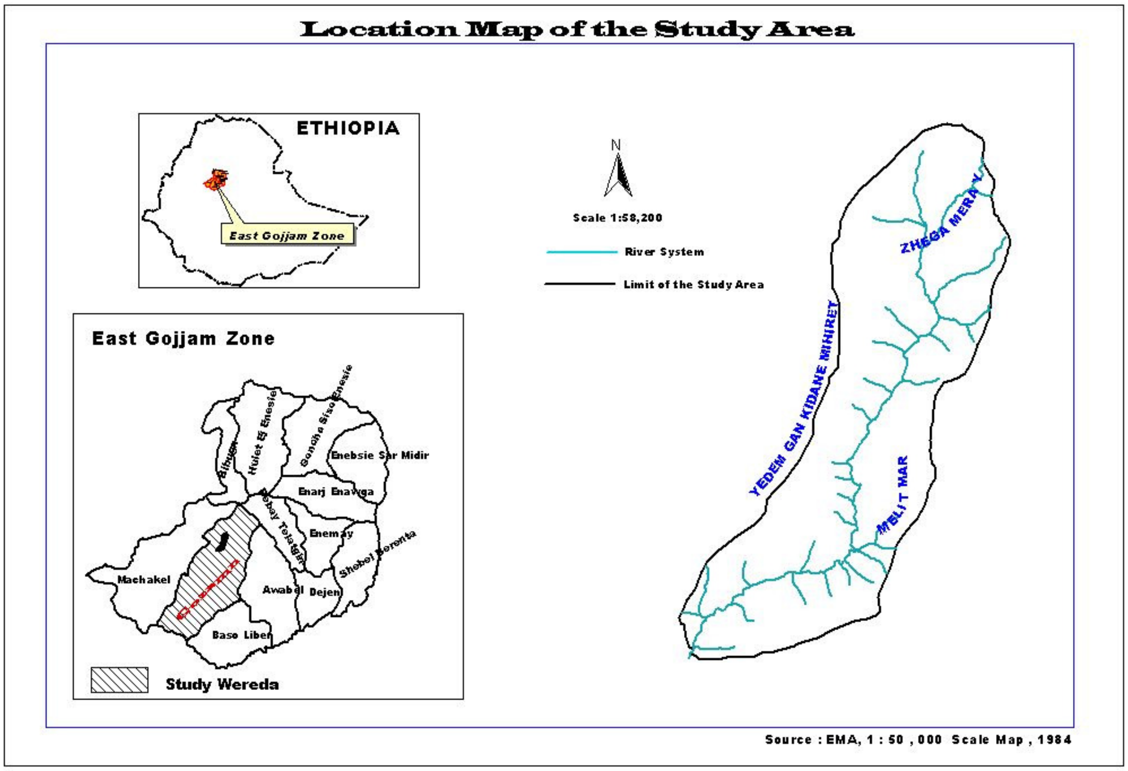
Improved land management that ensures better resource use and promotes long-term sustainability is basic to increased food production and to the economic welfare of rural communities. As agricultural land management is the actual practice of the use(s) and management of land by the users, understanding of the land users' land management system is indispensable to implement sustainable land management practices. In addition, it is widely argued that the indigenous technologies will ensure a more affordable and sustainable agricultural production if they are linked with the 'conventional' measures. Therefore, understanding the indigenous land management systems may reveal important clues for the development of alternative sound and sustainable land management systems. This is particularly true in poor countries like Ethiopia where 'conventional' technologies could not be found/afforded whenever and wherever demanded.

It is widely argued that Ethiopian farmers have long been aware of the problem associated with land degradation, and have traditionally been conservation minded at farm level (Krüger et al 1996). They usually use various mechanical, biological and agronomic techniques for managing their land. Different indigenous land management practices are still widely practiced by farmers of the country. However, in Ethiopia, these practices have been undermined and, therefore, understudied, and hence less integrated with the 'conventional' ones in order to achieve sustainable land management. Though they are less integrated and/or underused, they should still be considered as key inputs in the continuing development of land management systems. Therefore, linking these two measures is indispensable to achieve sustainable land management. Hence, investigating the possible ways of linking these two measures is fundamental. Here lies the significance of this study. The result of the study could hopefully contribute fruitful findings by identifying some of the constraints affecting successful land management practices by the farmers in the study watershed. The study could also enrich the existing literature for designing sound and sustainable land management practice in the study watershed. It also contributes to promoting appropriate conservation technologies as well as designing proper intervention polices and strategies for sustainable land management in the study watershed.

### *1.5 Materials and Methods*

#### *1.5.1. Description of the Study Watershed*

The watershed is located in *Gozamen* Wereda, East *Gojjam* Zone of *Amhara* Region. Astronomically, it is located between $10^0$25’-$10^0$30’ North and $37^0$42’-$37^0$44’ East, and situated approximately 308 km North-west of Addis Ababa and about 8 km North of *Debere Markos*. Its total area is approximately 2,461 ha.




The altitude of the study watershed ranges approximately from 2,380m to 2740m a.s.l. Agro-climatically, it is classified within the *'Dega'* agro-climatic zone which is located between 2,300m-3,000m a.s.l. (Daniel Gamachu 1977). Therefore, the watershed is characterized by humid climatic conditions and typically represents the 'Dega' zone of the traditional agro-climatic classification system of the country. The average annual rainfall and the mean annual temperature are estimated to be 1,300mm/year and $15^0$C, respectively, taking Debere Markos

Meteorological station (with an elevation of about 2411 m a.s.l) as a reference station. The rainfall is of unimodal pattern and much of the rainfall occurs in the months of June, July, August and September (locally known as '*kiremt'* season). The driest months are November, December, January and February (locally known as *bega* season)

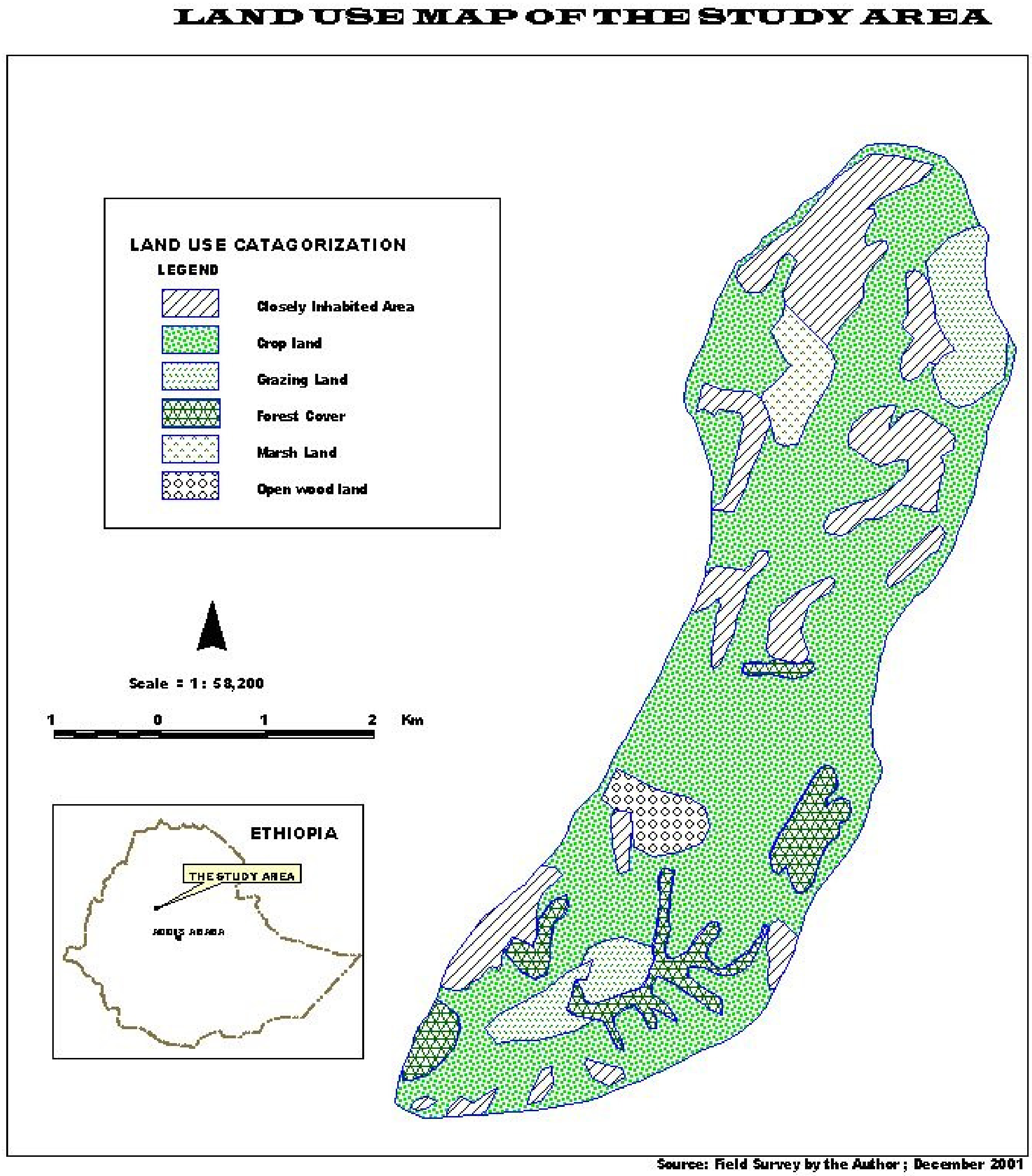
Livelihoods in the study watershed are primarily agricultural. The watershed is typical of the high-potential, intensively cultivated, mixed farming, ox-plough cereal belt in the northwestern Ethiopian highlands. The overall farming system is strongly oriented towards grain production and is dependent on the use of oxen for land preparation and traditional grazing on communal lands. There are two traditional and fundamentally different agro-technologies in the study watershed: the *"Maresha"* plough and hoe. Stony land which is not completely ploughed with *"Maresha"* and sloppy land which does not allow the *"Maresha"* are worked with a hoe.

The watershed is divided into various land use types settlement/closely inhabited villages (13.74%), Croplands (67.35%), Forest areas (7.11%), Marshland (2.38%), Open woodland (2.21%) and Grazing land (7.17%). This crude land use classification is based on the 1:50,000 topographic map of Debere Markos and own field survey.

Table 1.1. Land Use types of the Digil Watershed

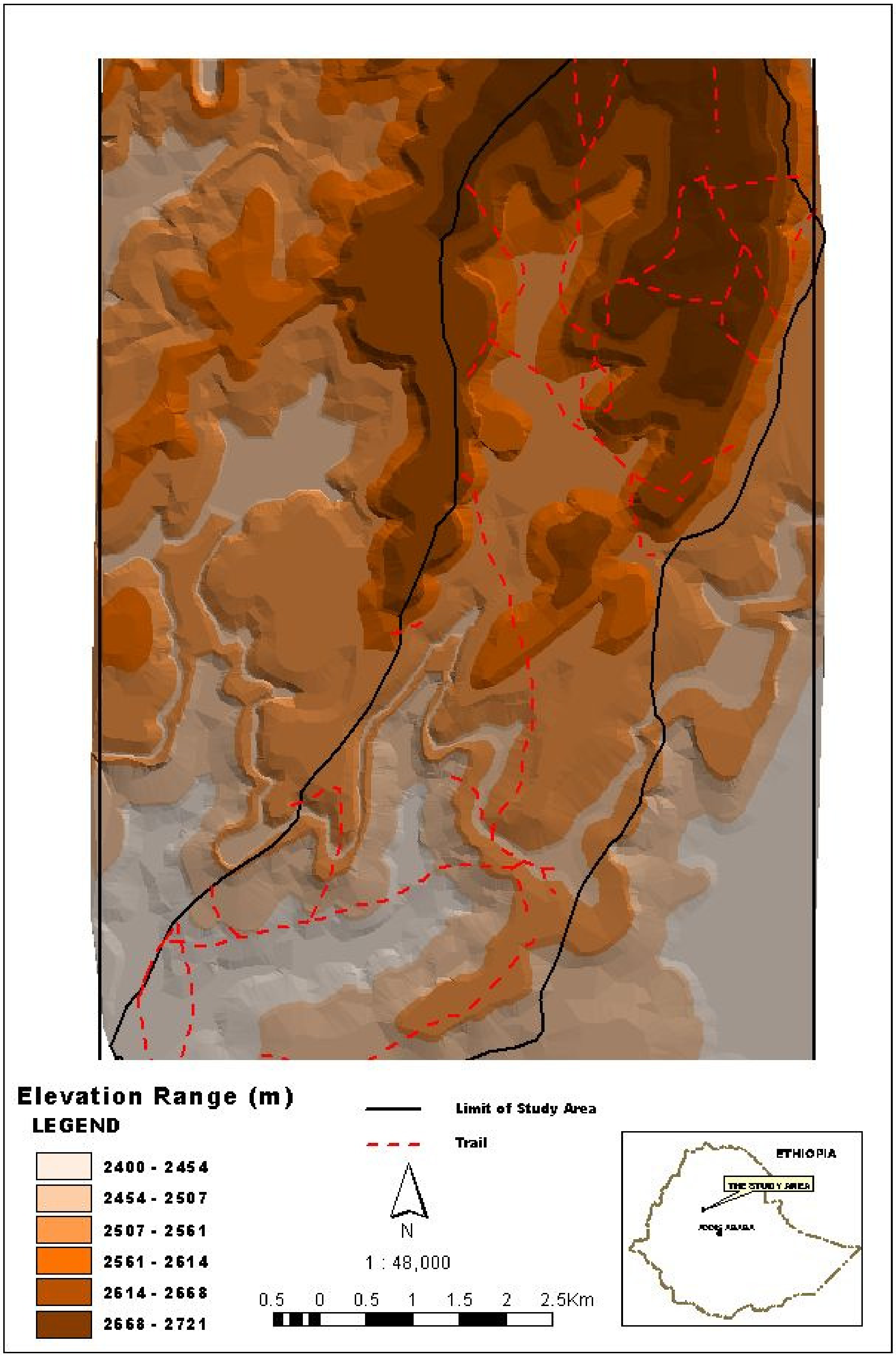
| Land use | Total area(ha) | Area(%) |
|---|---|---|
| Settlement/village | 338.1 | 13.74 |
| Cropland | 1657.6 | 67.35 |
| Grazing land | 176.5 | 7.17 |
| Forest area | 175.75 | 7.11 |
| Marsh land | 58.7 | 2.38 |
| Open wood land | 54.53 | 2.21 |
| Total Area | 2461.29 | 99.97 |

Source: Own field Survey, December 2001




The watershed has an extended growing period from April to December, *i.e*., over 240 days per year. The major crops vary and follow altitude zones. Generally, the crop types are divided in to two: subsistence crops and cash crops. Wheat, *teff*, Barely, Oats, Maize, Peas, Faba beans are some of the subsistence crops where as Noug, Flax, Rapeseed e.t.c. are some of the cash crops. From the subsistence crops *teff* was widely cultivated. But now it is replaced by Oats (‘*engdo’).*

DIGITAL ELEVATION MODEL OF THE STUDY AREA



### *1.5.2 Methods and procedures*

The study is based on field based survey of randomly selected households in different villages of the watershed. Both quantitative and qualitative data are utilized.

*i. Nature of the Data*

The socioeconomic as well as the demographic data that have relevance for the study were collected during the field survey. Land management practices [both indigenous and 'conventional'] were also explored. Moreover, the slope and the topsoil depth of about 60 randomly selected croplands were also observed. Secondary sources [both published and unpublished] were also consulted in order to substantiate the study.

*ii. Methods of Data Collection*

Questionnaire surveys, focus group discussions, key informant interview, discussion with the WoA conservation experts and Development Agents (DAs) and on-field observations were utilized to generate the data required for the analysis. In the questionnaire (household) survey, about 60 farmers were interviewed in the selected watershed using a structured questionnaire of both closed and open-ended questions.

The interviewees were selected using systematic random sampling technique. Here, the samples were taken from among those farmers who own cultivated fields. First, list of households was obtained from the *Kebele* administration. Then, the households were systematically grouped in to two: those who own cultivated land and those who do not own cultivated land. From those who own cultivated land 60 households were randomly selected. Considering the homogeneity of the households in their socio-economic and cultural aspects, these 60 households are believed to be representative of the inhabitants of the watershed.

The group discussion was held with at least four focus groups, each comprising of five to seven elders from the sampled villages. In addition, the slope and the topsoil depth of about 60 randomly selected croplands [, i.e., 20 plots treated with the ‘conventional’ measures, mainly, the *fanya juu* bunds and 40 treated with the indigenous measures] were observed during the filed work using clinometer and auger, respectively.

*iii. Methods of Data Analysis*

Both qualitative and quantitative techniques are employed in the research. Regarding the data obtained from the questionnaire survey simple descriptive statistics (percentiles, averages, etc) are found to be sufficient, and hence extensively used. For the analysis of the erosion risk in the observed croplands, the Treatment-Oriented Land Capability Classification (TO-LCC) scheme developed by Sheng(1977) and revised by Belay Tegene(2002) to be applicable in the Ethiopian condition, mainly, for the northern part of the country is used(see Appendix 2). In addition, attempt has been made to prepare, though it is crude, the land use map of the study watershed based on 1:50,000 topographic map of *Debre Markos*, using suitable GIS software, mainly ArcView GIS 3.2.

### *1.6 Organization of the paper*

The paper is organized in to six chapters in which the first part deals with introductory points. The second chapter contains the conceptual framework of the study and review of some related literatures. Agricultural land degradation in the study watershed is discussed in the third chapter. In chapter four, land management practices that were/are practiced in the study watershed are described. The possible ways of linking the indigenous and the ‘conventional’ measures are discussed in chapter five. Finally, some concluding remarks and recommendations are given on the basis of the findings.

### *1.7 Limitations of the Study*

The study explores the ways of linking indigenous with the 'conventional' ones for Sustainable Land Management in the Highlands of Ethiopia. In doing so, an attempt has been made to explore the indigenous and the 'conventional' land management practices, their strengths and/or weaknesses, the factors that affect farmers' decision to invest on and choice of land management measures, and then indicate the proper intervention approach. Being these are its major strengths, the study has some limitations due to the usual time, financial, skill etc. constraints. First, the biophysical conditions of the watershed are not assessed in-depth. Second, the technical and/or design aspects of both land management are not studied. Third, detailed land use map of the study watershed is not prepared.

# CHAPTER- II
# LITERATURE REVIEW

## *2.1. Conceptual Framework*

Meeting people's basic needs for food, water, shelter and employment, and there by improving human well-being, is considered as the central goal of Economic Development (UNEP 1993). These goals are achieved through "sustainable economic development – a development that does not compromise future economic productivity (UNEP 1993; Munasinghe and Lutze 1993). It is also argued that 'the long term productive capacity of any country's economy is closely linked with the rational use and management of natural resources and the protection of the environment (Bayou Lakew 1996). The idea is that "there needs to be a balance between protection of the environment in one hand and the demands of human and economic development on the other" (Munasinghe and Lutze 1993).

Environmental problems have the capacity to undermine economic and human development in a number of ways. Research findings reveal that continued economic development depends evermore on the maintenance or wise use of the natural resource base. The misuse, overuse and/or abuse of natural resources mainly renewable resources are considered as immediate threats for future economic development" (UNEP 1993). Nowadays, renewable [land] resources are becoming increasingly scarce and therefore needing effective management (Sfeir-Younis 1993; Nations 1993, Adams 1990). This is particularly true in countries of sub-Saharan Africa where people are confronted with a dilemma of limited land resources and the lack of appropriate technologies necessary for increasing food production.

Recognizing this several years ago, several remedial attempts have been made to solve the problem of land degradation, and hence sustainably manage land resources. Over the past several decades, different approaches have been used to tackle the problem of land degradation as well as promote sustainable land management practices.

### *2.1.1. Sustainable Land Management: Definition and Concept*

Sustainable land management has been defined as " the utilization of the land and its resources to meet the present needs while maintaining its productive capacity for future use"(Lawas 1997). Hurni (1997) also defined it as " a system of technologies and/or planning that aims to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra-and intergenerational equity". These definitions call for "integrating technologies, policies, and activities in the rural sector, particularly in agriculture, in such a way, as to enhance economic performance while maintaining the quality and environmental functions of the natural resources base. Sustainable land management in agriculture is said to be " a very complex and challenging concept" (Rais et al 1997). One of the challenges is "lack of comprehensive and quantifiable definition for it" (Dumansiki 1997). Though there is such a deficiency, the concept can be applied at different levels [global, continental, national, regional, local and village] and different scales [large, medium and small] to resolve different issues [socio-cultural, economic, ecological, and even political].

As indicated in Dumansiki(1997) the original concept of Sustainable Land Management was related to or associated with technologies that contribute to sustainable agriculture. Sustainable agriculture refers to the " successful management of resources for agriculture to satisfy changing human needs while enhancing the quality of the environment and conserving natural resources"(Dumansiki 1997). However, recently the concept is associated with not only 'technologies' but also with "the three development components: technology, policy and land use planning" (Hurni 1997). It encompasses biophysical, socioeconomic, and environmental concerns that must be viewed in an integrated manner. It combines technologies, polices and activities aimed at integrating socioeconomic principles with environmental concerns so as to simultaneously satisfy the five pillars of sustainable land management, i.e., *productivity, security, protection, viability, and acceptability* (Rais et al 1997; Hurni 1997; Dumansiki 1997; Muchena and Bleik 1997). Some scholars also argue that *'land use resilience'* and *'social equity'* should be added to the list of the pillars of sustainable land management. It is in line with this that sustainable land management concept attempts "to harmonize the complementary goals of providing environmental, economic and social opportunities for the benefit of the present and future generations, while maintaining and enhancing the quality of the land "(Dumansiki 1997).

In the concept of Sustainable Land Management, the term "management" refers to "an activity on the ground, using appropriate technologies in the respective land use systems"(Hurni 1997). The term 'appropriate technology' refers a technology that best fits a given land use system for a technology may not equally respond to all land use systems or it would unlikely to be applicable everywhere. Hurni (2000) gave the comprehensive definition of the term "land" as a "spatial units where ownership, resource availability, boundary conditions and the policy and economic environments play an important role". However, in this paper the term 'land' is used to mean agricultural land mainly cropland where ownership, resource availability, boundary conditions and the policy and economic environments play an important role in its management. The word 'sustainable' is used to refer to the long-lasting nature of 'the ways and means used to realize Sustainable Land Management (SLM) activities, and can be seen from different dimensions mainly the economic, social, institutional, political and ecological dimensions (Hurni 2000).

### *2.1.2. Approaches to Sustainable Land Management*

Over the past several decades, different approaches have been used to tackle the problem of agricultural land degradation and achieve sustainable land management in developing countries. These approaches were more or less the reflections of past rural or agricultural development interventions. These include 'production-centered' approach, 'people-centered' approach, 'multi-level stakeholder' approach, and recently 'Indigenous Knowledge (IK) Based' approach.

'Production-centered' approach was widely used in the 60's. In this approach advanced technologies were applied and farmers' were used as agents of economic production. In addition, due emphasis was given only to one of the five pillars of sustainable land management, that is, productivity. Literatures indicate that this approach was gradually replaced by the rural development strategies of the '70s, which aimed at meeting the basic needs of the rural population (Muchena and Bleik 1997). However, these early approaches were generally characterized by major weaknesses so that they were poorly accepted and adapted by farmers'. Some of the major weaknesses include the top-down approach used or technological imposition, their less participatory nature or neglect of the land users, inadequacy to understand the local biophysical conditions, and (above all) disregard Indigenous Knowledge of the land users (Mwale 1997; Lawas 1997).

A top-down approach and/or transfer of technologies from the external world characterized the early approaches of land management. Technologies developed in areas with totally different biophysical conditions were imposed on local people. In addition, local people were seen as "part of the problem to be solved despite the fact that those people survived with their approaches for centuries". "In some cases these technologies failed, in other cases they met with a lot of resistance to the extent that more effort was put in convincing the local people to adopt them" (Mwale 1997). The added weakness of past land management approaches was that they were not participatory. They did not encourage land users to participate in project design, implementation, operation, maintenance and monitoring. Though participation is considered as essential to reach the target group and respond appropriately to their needs, the early approaches of land management failed to do so.

Moreover, they were not helpful to understand the local biophysical conditions despite the fact that comprehensive land management requires knowledge and awareness of ecological interactions and interdependencies (Lawas 1997; Muchena and Bleik 1997). Disregard of resource users is the other weakness of the early land management approaches. In the past, resource users were not considered as important actors in the process of sustainable management of resources. Their practical activities were usually seen as contributing factors to the degradation of the resources. As a consequence, measures designed for sustainable management of resources only addresses the issues discerned by Scientists (Lawas 1997; Mwale 1997). During the '80s "people-centered" approach to development was developed, and it called for people's initiatives and was mainly based on the social, physical and economic resources under their control. Since '90s approaches that "create opportunities for the people to decide their own destiny and make their own choices have been, and are still being emphasized" (Muchena and Bleik 1997).

Recently, a " multi-level stakeholder approach to Sustainable Land Management" has been sought (Hurni 1997). According to the same author this approach "has been developed for finding feasible, acceptable, viable and ecologically sound solutions at local level". In the approach due emphasis is given to the use of 'appropriate' technologies, i.e., technologies that are ecologically protective, socially acceptable, economically viable, economically productive, and reduce risk as well as better respond to the 'respective' land use systems because any technology may not be applicable everywhere. As Hurni(2000) asserted such type of Sustainable Land Management approach can promote 'participatory land management solutions'. These solutions are again important in order to attain long lasting solutions for the problem in developing countries. But the main thing is that how participation of land users can be promoted and appropriate technology can be developed?

### *2.1.3. An Indigenous Knowledge (IK) Based Sustainable Land Management Approach*

Many specialists and policy makers now appreciate and acknowledge that the 'conventional' approaches to land management have failed with small-scale farmers in the developing tropical world. Land degradation continues unabated and land productivity continues to decline. Recognizing the previous failed land management approaches, a new approach has been developed. The approach is known as an Indigenous Knowledge (IK) based Sustainable Land Management approach. This approach is "based on the technical understanding of the land and the knowledge developed by the local people through years of continued and continuous land use". It is an approach based on the ecological and socio-economic understanding of the environment and the local people and their relationship. Fundamental to the new approach is the prerequisite for active participation and collaboration between the local land users and the 'interventionists'. This is achieved through the increase recognition of the importance of the Indigenous Knowledge of the farmers' (Mwale 1997).

*What is Indigenous Knowledge (IK)?*

Many authors and specialists have defined Indigenous Knowledge (IK) as the local or traditional knowledge, i.e., knowledge unique to a given culture. It contrasts with the international knowledge system generated by Universities, Research Institutes and Private Firms. It is considered as the basis for local-level decision making in agriculture, health care, food preparation, natural resource management, and a host of other activities in rural communities (Warren 1991; cited in World Bank 1998). It relates to "the ways members of a given community define and classify phenomenon in physical, social and ideational environment" (Kajembe and Routatora 1999; Lugeye 1999). It is the information base of a society, which facilitates communication and decision-making.

Indigenous Knowledge (IK) is also considered as "dynamic and continually influenced by internal creativity and experimentation as well as by contact with the external system" (Kajembe and Routatora 1999; Lugeye 1999; Lawas 1997). It is also referred to as " the body of knowledge, science and techniques used by rural people"(Swift 1979). It is characterized as dynamic and continuously adapted to changing circumstances and environmental conditions as well as passed from one generation to the next"(Krüger et al 1996) where as 'conventional' measures refer to the "body of knowledge, science and techniques introduced to the local people"(Swift 1979). As the survival of the local people has depended on their ecological awareness and adaptation, much of the Indigenous Knowledge (IK) is based on accurate, detailed and thoughtful observations collected and passed over many generations (Howes and Chambers 1979)

*Why an IK based land management?*

Nowadays, it is increasingly recognized that the land users themselves have valuable environmental knowledge contained in their Indigenous Knowledge (IK). In addition, the Indigenous Knowledge (IK) of local people is recognized as a basis for sustainable land management. Indigenous land management systems evolve within a given community's need to be stable and durable. Consequently, the local community develops land management measures that are suitable to the biophysical properties and fit the socio-economic conditions. It is thus very important to give due attention for the Indigenous Knowledge (IK) of a given locality as they form the basis on which sound land management measures can be developed (Mwale 1997). It provides the starting points for development of sustainable land management practices.

Basing 'conventional' land management measures on Indigenous Knowledge (IK) of land users also encourages the land users to actively participate in the land management activities as the success of land management activities often depends on local participation. As it is argued "familiarity with Indigenous Knowledge (IK) can help to understand and communicate with local people enhancing for participation and sustainable approaches to land management" (Warren 1992; Mwale 1997). In the past, often farmers' were not considered as important actors in the sustainable management of land resources. Their practical activities were usually seen as contributory factors to the land degradation. As a consequence, measures designed to sustainably manage the land resources only address the issue discerned by scientists (Mwale 1997). Previous experiences, however, have shown that without the participation of farmers', it is more likely that any effort to conserve and manage the land resources in a sustainable way would fail.

Recently, attention has been directed towards the crucial role farmers can play on land management activities. The question is how to involve the resource users, that is to say the farmers, in the land management activities. One way is to start understanding their unique knowledge or ways of using and managing their land. This may include comprehending their perception, actions or behavior towards land as well as recognizing farmers' knowledge as an important input in land resource management activities (Richards, 1979; Lawas 1997). Moreover, due emphasis is given on the integration of indigenous knowledge of rural people with the ‘conventional’ ones. Of course, sustainable land management in the future will be achieved if Indigenous Knowledge and practices are seriously taken into account and integrated with modern or ‘conventional’ ones (Reij et al 1996; Ellis-Jones and Tengberg, 2000).

As agricultural land management is the actual practice of the use(s) of land by the land users, understanding of the users [farmers] land management system is indispensable to implement sustainable land management practices. It is widely argued that the indigenous technologies will ensure a more affordable and sustainable solution if they are linked with the ‘conventional’ measures. Understanding the indigenous land management systems may, therefore, reveal important clues for the development of alternative sound and sustainable land management systems. The argument is based on: 1) the need to create more appropriate and environmentally friendly technologies; 2) empowering people like farmers to have greater control over their own destines; and 3) creating technologies that will have more just socioeconomic implications (De Walt 1994;Mushala 1997).

Literatures on the issue indicate that “land resource management recommendations derived from international knowledge systems seldom fully fit local needs and often prescribe practices that are costly to maintain. Modern technologies usually come in bits and pieces, and in order to fit them effectively into and build upon the local systems, we need to have a thorough understanding of Indigenous knowledge”(Kajembe and Routatora 1999). Emphasis should be given to the knowledge possessed by the rural people and to their capabilities for assimilating, adapting, communicating and creating knowledge. As Howes and Chambers

(1979) rightly put it "the richness and relevance of the stock of Indigenous Knowledge (IK) often goes unrecognized...rural people, free of disciplinary blinkers, usually not only know more about local conditions and needs but also take a more holistic view than specialists from outside. Their Indigenous Knowledge can complement organized science".

Indigenous Knowledge (IK) of rural people has largely been neglected and disregarded by policy-makers, researchers, etc. relied on the top-down strategy of technology transfer. "Only rarely is indigenous knowledge of peasants treated as knowledge in the mainstream of agricultural development. The culture-based knowledge of peasants is rejected as backward and counter-productive" (Dejene Aredo, n.d). However, it is believed that " to neglect the stock of indigenous knowledge, and the processes whereby rural people can assimilate, adapt, communicate and create knowledge, is both inefficient and wrong"(Brokensha et al 1980). Currently, it has been realized that "farmers are constantly engaged in the process of active innovation and invention, and are constantly reworking and updating their knowledge in the light of new challenges, and encounters with new forms of knowledge" (Mattee and Lassalle 1999).

The growing awareness of the limitations and hazards of 'conventional' methods has encouraged experts to look to Indigenous Knowledge as a major untapped resource for promoting sustainable land management practices and then developing sustainable agriculture (Mattee and Lassalle 1999). One of the solutions that have been proposed to redress this weakness is to work more closely with farmers. This is based on the acknowledgment of the central role of the farmer in the whole process of technology generation, dissemination and adoption (Reij et al 1996). This makes the farmers' to be recognized as the only ones who are able to combine 'indigenous' with 'conventional', and can bring permanent change in the society. Therefore, as it is argued, any development effort must start from and recognize the local capacities of the local people, rather than exclusively relaying on modern scientific knowledge. Much emphasis should be put on the developmental relevance of Indigenous Knowledge. Tested and passed on many generations, and well adapted to ecological conditions, indigenous practices and technologies are assumed to offer a sound base for any development (Brokensha et al 1980), including land management.

### *2.2. Related Literature*

#### *2.2.1. Agricultural Land Degradation in the Highlands of Ethiopia with particular emphasis on the north-western highlands*

Land degradation in the Ethiopian highlands (i.e. areas above 1500m.a.s.l) has been a concern for many years. The problem occurs in the form of soil erosion, nutrient depletion and deforestation. Vast areas of these highlands have been classified as suffering from severe to moderate soil degradation. Though the extent varies from place to place, the northern and the central highlands of the country are most seriously affected (Solomon Abate 1994).

The human-induced soil erosion and soil fertility deterioration are mainly considered as serious problems. Soil erosion by water is a serious problem as well as threat to agricultural productivity in the highlands. FAO (1986) estimated that one–half of the arable lands in the highlands are moderately to severely eroded (FAO 1986; cited in Shiferaw and Holden 1999). Estimated soil erosion on croplands averages 42 tons per hectare in the highlands, though it is much higher on the steeper slopes and for some crops. More than 6 million hectares of additional cropland and pasture in the highlands may become unusable (with less than 10 cm of depth) between 1985 and 2010 if estimated erosion rates continue unabated (Stucliffe 1993; cited in Pender et al 1999). Similarly, land degradation in the north-western highlands occurs in the form of soil erosion and soil nutrient depletion.  Soil erosion by water is the dominant form of erosion. In the highly degraded areas of the Region, shallow depth and poor fertility situation characterize the soils so that farmers' are forced to make a living from these poor and shallow soils.

According to Gete Zeleke (2000) the highlands of Gojjam are the main supplier of surplus cereals to the rest of the country. They are believed to be "the traditional 'breadbasket of Ethiopia,' known for abundant cereal production and export of surplus to major Ethiopian cities' (Gete Zeleke and Hurni 2001). However, the current land degradation problems [soil erosion and soil fertility decline] are undermining this potential. That is, given the current trends of land degradation, these highlands will no longer be able to supply surplus agricultural products to the rest of the country and will soon fail to satisfy even the food demand of their own population (Gete Zeleke 2000; Gete Zeleke and Hurni 2001). Despite all these, the highlands of Gojjam are still considered to be an area of great agricultural potential. Therefore, sustaining this potential is a crucial step that must be undertaken in order to secure the food supply of the country.

*Severity /Extent of Land Degradation*

The rate of land degradation in the highlands of Gojjam, is reported to be exceptionally high, and is also considered as a threat to its agricultural potential. It is reported that the soil loss rate from the cultivated areas of these highlands is higher than in the rest of the country and soil productivity is decreasing very fast (up to 5% per year) (Gete Zeleke 2000). Measured soil loss, for instance in Anjeni Research Unit (Gojjam), was reported to be as high as 320 and 263 tons/hectare/year on bare and cultivated plots, respectively. The long-term average soil erosion rates from cultivated plots are reported to be the highest among nation-wide monitored sites and range between 131 and 170 tons/hectare/year. As it is noted the current soil erosion rate in these areas, especially on cultivated lands, is extraordinary and exceeds the soil formation rate by a factor of 10 to 15. This rate is rather very alarming and deserves serious recognition before the soil potential is degraded beyond recovery (Gete Zeleke 2000).

*Causes of Land Degradation*

The factors contributing to land degradation are varied, complex and interrelated. They can be human, physical, and socio-economic. The following tables illustrate the proximate and/or direct causes of land degradation in the region at large.

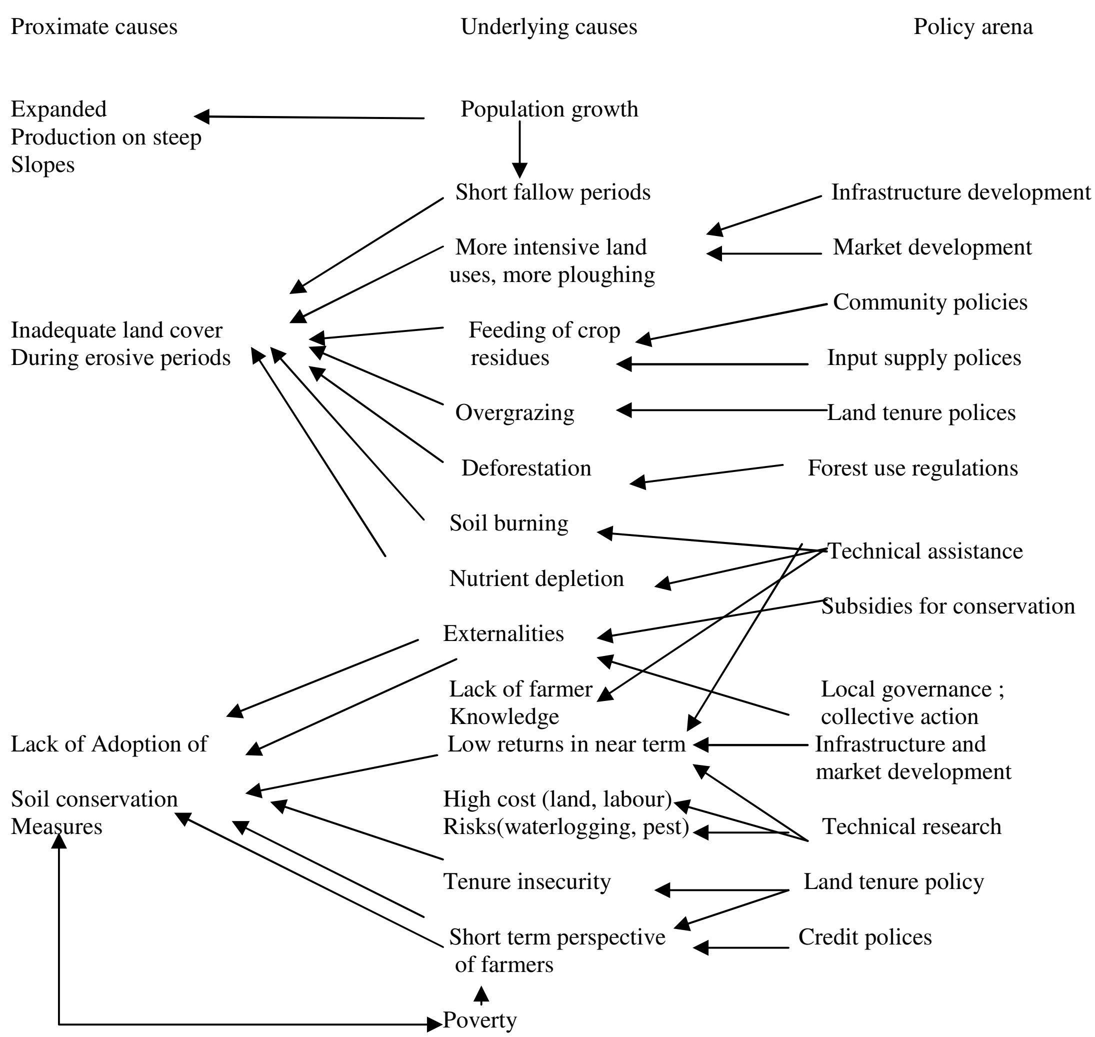



Figure 2.1. Causes of soil erosion in Amhara Region, adopted from Lakew Desta et al 2000

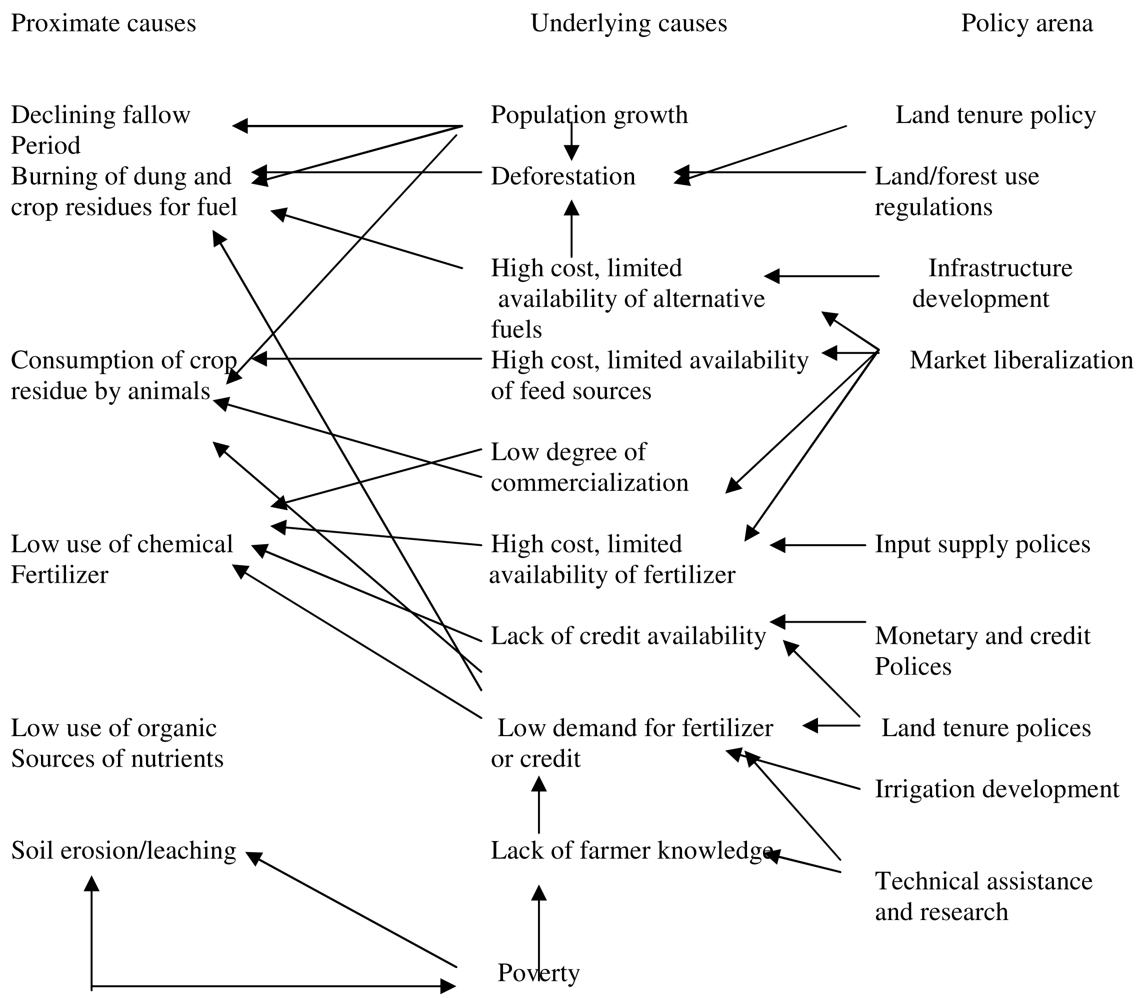



Figure 2.2 Causes of soil nutrient decline in Amhara Region, adopted from Lakew Desta et al 2000

*Natural factors: High Intensity of Rainfall Vs Steep Slope*

Of the natural factors causing land degradation, high intensity of rainfall and relief with steep slope are considered to be the major ones. The most important natural factor that causes land degradation in the north-western highlands is probably 'high intensity of rainfall'. The impact of raindrops, with tremendous amounts of energy, on the bare unprotected soil starts the process of erosion by water (Hudson 1981; Morgan 1986). Rainfall with high intensity is particularly responsible for sheet erosion, i.e., the removal of the surface soil in thin layers, or "sheets," or more or less uniformly from a broader area of soil. Soil particles are detached primarily by raindrops impacting the soil and are transported mainly by sheet flow of water. While sheet erosion is the least spectacular in the field, it is the most extensive and probably the most damaging kind of erosion worldwide (Frye 1987).

The other important biophysical factor determining vulnerability of soils to erosion is the slope gradient. Particularly, the steep slopes encourage erosion by increasing the volume and the velocity of the runoff and by encouraging the down slope movement of soils due tillage. When runs off rapidly on steep slopes and hence only a limited proportion of the rainwater can infiltrate into the soil, whereas on gentler slopes the slower flow on the surface allows percolation of a large proportion (Belay Tegene 2002).

*Socio-economic and Institutional Factors*

Lakew Desta et al (2000) identified different socio-economic and institutional factors that affect land degradation in the region through their impacts on farmers decision with respect to land use and land management practices, such as ploughing, fallow, use of manure and other sources of organic matter, fertilizer use, and adoption of soil and water conservation measures.

*Population Pressure: Human and Livestock Population*

The prime factor that affects land resource condition is believed to be population growth. Human population in the country is increasing at an alarmingly high rate [about 3% per year](NoP-MEDaC 1999). The same is true in the northwestern highlands where the population is growing at an alarming rate. This creates pressure on land resource. This in turn leads to decline in the productive capacity of soil resources, which is necessary to sustain the population. The impact of population pressure on land is reflected in the increasing man-land ratio [which results frequent land redistribution], deforestation, expansion of croplands to marginal areas, continuous cultivation of croplands (decrease in the number of fallow years), overgrazing, etc. (Gete Zeleke 2000).

*Population Pressure: Frequent Land Redistribution*

Frequent land redistribution may result severe fragmentation of plots, a reduction of crop fields and may create sense of insecurity on the land users. This situation in turn has adverse implications on land resources, particularly croplands. Fragmented holdings may have different negative impacts on the management of croplands. When holdings are intensively fragmented, much time and energy are lost in moving from one plot to another. So this situation aggravates land degradation. As it is argued reduction of cropland per capita and insecurity have led to reduction in activities such as fallowing, planting trees and investing in conservation structures (Yeraswork Admassie 2000; Lakew Desta et al 2000). So, reduction in the above-mentioned activities and shifting of cropping and grazing activities into fragile lands results land degradation.

*Population Pressure: Expansion of Croplands to Ecologically Fragile lands*

The most important impact of population pressure on land resources is expansion of croplands to ecologically fragile lands such as steep slope areas. This is particularly true in the north-western highlands where the farming system is based on 'claming more land for cultivation as opposed to maximizing production per unit area. This situation demands expanding the croplands either towards the steep slope areas or on flat and swampy areas or both. Some reports reveal that areas with slopes >100% (see Gete Zeleke 2000) have been used for crop production without any special land management practices except for some traditional ditches dug diagonally with average slope ranging from 50 to 60%. The same report also indicates that flat lands which are located around rivers that have seasonal flooding problems, and swampy areas that are not currently suitable for crop cultivation are used for crop cultivation. This situation was also observed in South Welo, where areas above 60% slope were used for cultivation purpose (Belay Tegene 1998a; 1998b).

*Population Pressure: Deforestation*

The need to expand crop or grazing land mainly through deforestation leads to land degradation. Farmers' used to clear natural vegetation in order to get cropland for crop cultivation and cope up with the growing population's demand for food and cultivated land. This situation, therefore, aggravates the land degradation problem and causes high loss of soil productivity. But currently due to almost complete conversion of all areas in to croplands in this region these practices are no more important. In addition, population growth increases the demand for fuelwood, which in turn leads to the destruction of forests as well as increase in the use of crop residues and dung for fuel rather than as a source of organic fertilizer to improve the already degraded or poor soils of the region.

Excess removal of forests is contributing to land degradation. About 20 thousand hectares of forest are harvested annually in the Amahar Region for fuelwood, logging and construction purposes. Since harvested trees are not replaced adequately by tree planting, soils are exposed to high intensity of rainfall and about 1.9 to 3.5 billion tonnes of fertile topsoil are washed annually into rivers and lakes due to deforestation alone (BoA 1997, cited in Lakew Desta et al 2000).

*The Farming System: Exploitative Agricultural Practices*

The other cause of land degradation in the study highlands is probably the farming system itself. Agriculture in the north-western highlands is characterized by a subsistence rainfed production system with simple traditional methods of production, dominated by the ox-plough and cereal production. Cropping of cereals aggravates land degradation, as farmland requires repeated ploughing and need fine seedbed preparation (heavy pulverization) before sowing. Due to this process the cropland remains bare or with little ground cover during the onset of the most erosive storms of June, July and August (Gete Zeleke 2000). In addition, the farming practice is reported to be responsible for the loss of soils due to tillage erosion. Tillage by ox-plough causes down slope transfer of large mass of soils in Ethiopia (Belay Tegene 2000a, 2002). This is may common in the study watershed as the tillage operations are conducted using the ox-plough.

*Grazing Pressure: Livestock stocking Rates Vs Free Grazing System*

The free grazing system as well as the expansion of the livestock population is the added factors that aggravate land degradation in the region. Shortage of land has its own repercussions on livestock stocking rates as well as the grazing system. Most of the land that is fertile is reserved for crop production, while grazing of cattle and other livestock is limited to swampy valley bottomlands and marginal deforested hillsides. Hillsides that are supposed to be closed off for regeneration are kept under intensive grazing until they are completely bare and then abandoned. This, hillside grazing, is practiced as an adaptation to the expansion of cropland and shortage of grazing land (Lakew Desta et al 2000).

Soil fertility is also declining in many parts the country in general and the northwestern highlands in particular. Corbeels et al (2000) indicates that "one of the major constraints to crop production faced by smallholder subsistence farmers is the inadequate supply of nutrients". Several factors have been suggested as causes for the declining of soil fertility in the highland parts of the country in general and north-western highlands in particular. One of the causes is assumed to be farmers abandoning of the traditional practices of using natural fallow to restore soil fertility or their inability to leave land fallow for long enough for it to be effective. Increasing scarcity of cultivable land due to growing populations and land degradation are believed to hinder peasants leaving land idle to regenerate its fertility through fallowing. In addition, it is also assumed that "higher opportunity costs for fuel and feeding livestock hamper the traditional use of dung and crop residues for regenerating soil fertility"(Shiferaw and Holden 1999). Dung and agricultural residues are estimated to provide up to 50% of the household's energy supply.

In the past much research emphasis was put on trials " to determine the appropriate amount and type of fertilizer needed to obtain the best yields for particular soil types and agro-ecological locations"(Corbeels et al 2000). However, the use of mineral fertilizers is declining as they are increasingly beyond the means of most small-scale farmers. The level of use of purchased yield-enhancing inputs is very low; improved seeds, irrigation, and fertilizer are used only 0.7, 1, and 25% of the cultivated fields (Shiferaw and Holden 1999). Therefore, sustaining soil fertility through improving farmers' knowledge is considered as an essential element in the development of integrated fertility management practices (Corbeels et al 2000).

### *2.2.2 Past Attempts of Land Management in the Highlands of Ethiopia with particular emphasis to north-western highlands*

So far different attempts have been made to manage the land in the highland parts of Ethiopia through different land rehabilitation attempts such as afforestation, terracing, and water harvesting and area closure. The largest work was that carried out between 1976 and 1993, in which peasants were mobilized to participate either via food for work payments or just by force (Shiferaw and Holden 1999;Lakew Desta 2000; Woldeamlak Bewket 2001; Woldeamlak Bewket and Sterk 2002). Belay Tegene(1998a) also reported that "the Ethiopian Highlands saw the most extensive soil conservation activities in Africa in the 1970s and 1980s". Though they failed to win acceptance by the land users because of their multifaceted limitations and constraints, the *fanya juu* and normal bunds were the newly introduced and widely applied conservation measures in the Highland parts of the country (Belay Tegene 1998a). Nowadays, it is reported that different land resources management activities have been ongoing and have progressed substantially in the Amhara region, especially since 1992. As Lakew et al (2000) reported, only 9000 ha of land was terraced in1992/93 compared with 219,214 by 1999 through community mobilization and food-for-work programmes, in which an estimated 3.7 million people participated with 34.8 million man-days. Here lies the limitation of the approach of the land resources management in the Region though it is reported as a success. This is because such type of land resources management process, through community mobilization and food-for-work programmes, may not be based on the real participation of land user's

Table 2.1 Soil and Water Conservation Activities through Mass Mobilization in Amhara, 1992-93 to 1997-98

| Activities | 1992-93 | 1993-94 | 1994-95 | 1995-96 | 1996-97 | 1997-98 |
|---|---|---|---|---|---|---|
| Conservation of terraces(ha) | 9,604 | 17,686 | 39, 321 | 80,565 | 137,726 | 176,419 |
| Maintenance of terraces(ha) | 1,494 | 2,601 | 4,852 | 10,209 | 26,163 | 44,286 |
| Construction of microbasin(x$10^3$) | 675 | 730 | 1,007 | 789 | 1,271 | n.a. |
| Construction of check dams (km) | 194 | 509 | 861 | 1,169 | 1,520 | 1,580 |
| Maintenance of check dams (km) | n.a. | 65 | n.a. | 478 | 543 | 746 |
| Construction of cutoff drains (km) | 199 | 290 | 964 | 979 | 1,312 | 1,655 |
| Artificial water ways(km) | 10 | 55 | 129 | 339 | 621 | 793 |
| Grass strips (ha) | 15 | 17 | 59 | 155 | 277 | 1,278 |
| Tree planting(ha) | 23,038 | 7,936 | 23,858 | 25,990 | n.a. | n.a |
| Area closure(ha) | 6,749 | 10,122 | 15,342 | 10,565 | n.a. | 11,944 |
| Farmers training (number) | 573 | 13,991 | 20,587 | 57,046 | 96,572 | n.a. |

Source: Lakew Desta et al 2000, p36
The figures are year specific and not cumulative
n.a.= data not available

As indicated else where new land management technologies developed by researchers were and still are introduced though their acceptance by the land users was and still is very limited. The new technologies were disseminated to farmers, but failed to be accepted, and hence adapted by the land users (Belay Tegene 1998a;Lakew Desta 2000). In the past land management strategies and practices were dominated, in the words of Desalegn Rahmato, by 'state environmentalism' (Desalegn Rahmato 2001). The main assumption in this type of environmentalism is that environmental protection [land management] is the responsibility of the government. The state was considered as responsible to "introduce the appropriate conservation technology and 'transfer' such technology to the population concerned". These assumptions could only lead to, as he argued, a "unilateral" course of action, and an undemocratic approach". Continuing the argument the author noted that previous land management programs were always "imposed from above, and rural land users – the people directly affected by environmental change-were rarely consulted". This clearly indicates that there has been" the issue of dispossession and disempowerment of the people who are closest to the environment by people who are furthest removed from it".

The Ethiopian highlands are home of many millions of small-scale farmers. These farmers' do have their own "diverse and indigenous ways of land management practices" (Krüger et al 1996). However, there seems to be lack of appreciation of indigenous land management practices by experts and policy-makers in the country (Dejene Aredo, n.d). Ethiopian farmers have long been aware of the problems associated with land degradation, and have traditionally been conservation minded at farm level. Despite this fact the knowledge, skills, survival strategies and risks faced by farmers operating with low external input have been ignored frequently by outsiders and experts promoting 'modern' conservation techniques. The result is that many 'conventional' measures have proved to be ill adapted to the existing systems (Desalegn Rahamto 2001; Krüger et al 1996; Singh 1999; Lakew Desta 2000). They were simply applied before they were adapted to the environment and farming systems and farmers were rarely consulted on the choice of methods or planning their placement (Belay Tegene 1998a).

### *2.2.3. Indigenous Land Management Practices*

Ethiopian peasants have a wide variety of indigenous land management techniques that they have been employing for generations though some of them are in danger of being lost (Dejene Aredo, n.d; Krüger et al 1996; Lakew Desta 2000; Desalegn Rahmato 2001). These measures are broadly grouped as physical, vegetative, and agronomic methods. These measures are the result of a "gradual learning process and emerge from a knowledge base accumulated by rural people by observation, experimentation, and a process of handing down through generations people's experience and wisdom" (Krüger et al 1996). These practices are also shaped by and emerge from a detailed understanding of local conditions, and are modified in response to changing socio-economic, political and ecological conditions.

Physical Measures: there are various indigenous physical soil conservation techniques that are applied to control erosion in the Highland parts of the country. These measures include: *stone bund, traditional ditches, unploughed strip, traditional water ways, traditional cutoff drain, raised bed (furrow, broad bed), traditional checkdam, bench terrace, scattered bund, runoff diversion, trash line along the contour, etc.* These measures are applied with wide range of flexibility. In addition, some of them are implemented over a course of time. They are initiated in one cropping season and are extended to the next (Belay Tegene 1998a; Lakew Desta 2000). For instance, maintenance and gradual development of well stabilized stone bund takes a number of years contrary to a quick establishment of the 'conventional' ones. Belay Tegene(1998a) reported "the wide application of an indigenous physical soil conservation measure which is known as *weber* in South Welo". According to the report the wide application of *weber* in the region is based on (1) the farmers' perception of the problem and their survival strategies, and (2) its compatibility with the environment, land-use and farming system. Different physical measures are designed to serve different purposes such as soil and water conservation (stone bund, unploughed strip, traditional check dam), drainage (traditional cutoff drain, raised bed, traditional waterway), and boundary (unploughed strip).

Vegetative measures: different vegetative measures are widely applied in the highlands of Ethiopia. These include: *grass strip (local species), planting sensel(Adhatoda shimperiana), Planting Bamboo(Arundinaria alpina), Planting Rid(Arundinaria donax), Planting sisal, kincheb, Ret, planting trees on stone bunds, Planting Eragorostis grass, Area closure, etc.* It is noted that most of the time the vegetative measures are applied on physical measures or alone (Lakew Desta 2000). Similarly, farmers also apply agro-forestry measures. They integrate different trees in the farming system. Some of the trees are *Acacia abisinica, Acacia albida, Acacia ceyal, Acacia nilotica, Balanites aegyatica, Croton macrostachyus, Dichrostachys cinerea, etc* (Lakew Desta 2000).

Agronomic conservation practices: the main types of traditional agronomic conservation practices include mixed cropping, organic manuring, fallowing, cow dung manuring, cropping 'gibto'(Lupines lupine), animal parking(temporary kraal), weed heaps, management of scattered stones, soil burning(gay), etc.(Lakew Desta 2000). For instance, mixed cropping plays a significant role in increasing the crop canopy, improving the soil cover and reducing run off and soil loss (Belay Tegene 1998a). These measures do have dual purposes: (1) they improve the fertility of soils, and (2) reduce soil loss. They are not only introduced to reduce soil loss or manage runoff, but they are also designed to improve the productivity and suitability of land for cultivation. Pool of indigenous soil fertility management practices is also found in the country. The most common practices are fallowing, crop rotation, application of crop residues, manuring, and incorporation of weeds, etc. (Belay Tegene 1998b; Corbeels et al 2000).

# CHAPTER-III

## AGRICULTURAL LAND DEGRADATION, FARMERS KNOWLEDGE OF SOILS AND THEIR PERCEPTION OF THE LAND DEGRADATION PROBLEM.

In this section an attempt has been made to explore the severity/extent, causes and major types of land degradation in the study watershed. In addition, the perception of farmers' of the study watershed concerning the causes, extent and types of the problems are explored based on the data generated through household survey, on-site observation, group discussion with farmers' as well as based on discussions with key informants. Moreover, secondary sources are consulted in order to substantiate the discussions.

### *3.1. Severity, Causes, and Types of Agricultural Land Degradation in the Study Watershed*

The land degradation problem is becoming a serious problem. Soil erosion by water further aggravated by faulty tillage operations is serious problem as well as threat to agricultural productivity in the highlands where the study watershed is located. The factors contributing to soil degradation are varied, complex and interrelated. They can be biophysical or socio-economic. Several biophysical factors can cause soil erosion by water. These include the slope gradient and the rainfall characteristics [, i.e., high rainfall erosivity](Krauer 1988).

An attempt has been made to group the observed croplands into erosion risk classes on the basis of topsoil depth and slope following the procedures of the revised Treatment-Oriented (TO) Capability Classification scheme (Belay Tegene, 2002)(see Appendix 2). The rationale of using these two factors for classifying croplands to erosion risk classes is that erosion is very much increased with increasing slope gradient. The vulnerability of soils to irreversible loss is also increased with reduced soil depth. Hence, erosion risk was evaluated using the revised Treatment-Oriented Land Capability Classification scheme in the study watershed.

From the total observed 60 plots about 18.28% are moderately deep (50-90 cm) and 81.59% are shallow (20-50cm). Regarding their slope gradient about 39.99%, 43.29%, 6.66%, 5%, 1.66%, and 3.3% are located in Gently sloping (<12%), Moderately sloping (12-27%), Strongly Sloping (27-36%), Very strongly sloping (36-47%), Steep (47-58%), and Very steep slope (>58%), respectively.

Table 3.1 Slope-Topsoil Depth Relationship of the observed croplands

| Slope / Soil Depth | Gently Sloping | Moderately sloping | Strongly sloping | V. strongly sloping | Steep | Very steep |
|---|---|---|---|---|---|---|
| | (<12%) (< $7^0$) | (12-27%) (7-$15^0$) | (27-36%) (15-$20^0$) | (36-47%) (20-$25^0$) | (47-58%) (25-$30^0$) | (>58%) (>$30^0$) |
| Deep (>90cm) | - | - | - | - | - | - |
| Mod. Deep (50-90cm) | 11.66 | 4.96 | 1.66 | - | - | - |
| Shallow (20-50cm | 28.3 | 38.3 | 5 | 5 | 1.66 | 3.33 |
| V. shallow (<20cm) | - | - | - | - | - | - |

Source: Own field Survey, December 2001
* Shows the percentage distribution of plots

Combining the slope and soil depth it was possible to group croplands into capability classes. About 45.95% of the plots were found to fall under C1 (39.33 %), C2 (4.96%), and C3 (1.66%) capability units and hence are suitable for cropping. Their conservation measure requirement varies from class to class. For instance, the C1 can be cultivated with no or few conservation measures [strip cropping, contour cultivation](See Appendix 3 for details). Capability classes C2/P and C3/P, which should be used for annual cropping with only intensive conservation measures like bench terraces accounted for about 38.3 per cent and 5.5 per cent, respectively. Moreover, some 10 per cent of the currently cultivated land belong to capability classes P and F and should be left as pasture and forest cover. This clearly reveals that farmers' are currently pushing crop cultivation into lands that are not capable for crop production with the available conservation measures.

The most important factor behind the expansion of croplands to fragile slopes is population pressure. This is particularly true in the study watershed in particular where the farming system is based on claiming more land for cultivation as opposed to maximizing production per unit area like other parts of the north-western highlands. This situation demands expanding the croplands either towards the steep slope areas or on flat and swampy areas or both. The need to expand crop or grazing land mainly through deforestation leads to land degradation. Farmers' used to clear natural vegetation in order to get cropland. According to Gete Zeleke and Hurni(2001) " the age-old agricultural tradition of clearing the land ( traditionally called *merete makeinat*) was extensively practiced" in most parts of the highlands of Gojjam, including the study watershed, in the past four decades or so. This was done in order to get additional land for crop cultivation and cope up with the growing population's demand for food and cultivated land. This situation, therefore, aggravates the land degradation problem and causes high loss of soil productivity.

Table 3.2. Distribution of the observed plots in the modified Treatment-Oriented Land Capability Classification types (%).

| TO-LCC | Plots Observed |
|---|---|
| C1 | 39.33 |
| C2 | 4.96 |
| C3 | 1.66 |
| C4 | - |
| C1/P | - |
| C2/P | 38.3 |
| C3/P | 5.5 |
| C4/P | - |
| P | 5 |
| FT | - |
| FT/F | - |
| F | 5 |
| Total | 100 |

Source: Own Field Survey, December 2001

The other natural factor that causes land degradation in the study watershed is probably 'high intensity of rainfall'. The impact of raindrops, with tremendous amounts of energy, on the bare unprotected soil starts the process of erosion by water (Morgan 1986). Rainfall with high intensity is particularly responsible for sheet erosion. Soil particles are detached primarily by raindrops impacting the soil and are transported mainly by sheet flow of water. While sheet erosion is the least noticeable in the field, it is the most extensive and probably the most damaging kind of erosion worldwide (Frye 1987). The rainfall in the study watershed concentrates in five to six months and hence very erosive. These intensive rains encourage accelerated erosion on cultivated fields not only by detaching soil particles but also generating the runoff that transport them. In addition, cultivation and seedbed preparation is undertaken at a time of the year when heavy storms are usual [, that is, July]. This results plant nutrients and the finer soil particles to be washed out of the cultivated layer, either downwards into deeper horizons or outside the cultivated field (Krauer 1988).

*Socio-economic and Institutional Factors*

Different socio-economic and institutional factors may cause land degradation in the study watershed through their impacts on farmers' decision with respect to land use and land management practices. The prime factor that affects land resource condition is believed to be population growth. It creates pressure on land resource. This in turn leads to decline in the productive capacity of soil resources, which is necessary to sustain the population. The impact of population pressure on land is reflected in the increasing man-land ratio [which results frequent land redistribution], deforestation, expansion of croplands to marginal areas, continuous cultivation of croplands overgrazing, etc.

The other socioeconomic cause for land degradation in the watershed is land fragmentation due to frequent land redistribution. In addition to other minor land redistributions there were two major land distributions in the study watershed, i.e., the 1970s and the 1997 land distributions (Lakew Desta et al 2000). Frequent land redistribution may result severe fragmentation of plots, a reduction in the area of land and may create sense of insecurity of ownership among the land users. This situation in turn has adverse implications on land resources, particularly croplands. Fragmented holdings may also have different adverse effects on the management of croplands. When holdings are intensively fragmented and scattered much time and energy are lost in moving from one plot to another. In addition, reduction of cropland per capita and insecurity of land tenure have led to reduction in activities such as fallowing, planting of trees and investing on conservation structures (Yerasework Admassie 2000), all of which may result land degradation.

The other cause of land degradation in the study watershed is probably the farming system itself. Agriculture in the study watershed is characterized by a subsistence rainfed production system with simple traditional methods of production, dominated by the ox-plough and cereal production. Cropping of some cereals, mainly cereals of fine seeds, aggravates land degradation, as the farmland requires repeated ploughing and need fine seedbed preparation (heavy pulverization) before sowing. Due to this process the cropland remains bare or with little ground cover during the onset of the most erosive storms of June, July and August (Gete Zeleke 2000). For instance, *teff,* the staple and cash crop of many Ethiopians, is one of the most important cereals grown in the study watershed. This crop has very fine seeds so that it requires very fine seedbed preparation, i.e., five to six ploughings before sowing. After this, the seedbed has to be trampled with animal tracks a few minutes before sowing. The soil after trampling is almost compacted and all plough ridges are destroyed. Traditionally, according to farmers', trampling is performed to avoid burial of seeds under ridges and to minimize weed infestation. Nevertheless, it was reported that this practice reduces the infiltration capacity of soils as well as surface storage. And again, these situations, i.e., reduction of infiltration capacity and the reduction of surface storage, in turn induce high runoff rates and hence accelerated soil erosion (Gete Zeleke 2000;Million Alemayehu, 1992; Belay Tegene 1992a). Generally, the exploitative nature of the farming system aggravates loss of soils either through water erosion or tillage erosion.

The free grazing system as well as the increase in livestock population in the area are the added factors that aggravate land degradation. As it is indicated in the literature review part, shortage of land has its own repercussions on livestock stocking rates as well as the grazing system. Currently, grazing is limited to swampy valley bottomlands and marginal deforested hillsides. Hillsides are kept under intensive grazing until they are completely bare and then abandoned. Hillside grazing is practiced as an adaptation to the expansion of cropland and shortage of grazing land (Lakew Desta et al 2000). Moreover, free grazing after the crops are harvested is a common practice. Mixed livestock are free to walk around in all areas, including very steep slopes. The expansion of the livestock population beyond the carrying capacity of the land exacerbates the degradation of soil mainly through overgrazing. As noted by Gete Zeleke (2000) “livestock density results in surface compaction, increased run-off and accelerated erosion”. Not only increasing livestock density results degradation but grazing the already degraded lands also aggravates the problem. Groups of livestock are made to stay on these lands, especially during the cropping season. This indicates that both the cultivation and the livestock are pushed towards marginal lands which eventually results in even more severe land degradation.

Recently, faulty/defective and damaged conservation structures are becoming the most important causes of rill erosion and (above all) gully erosion in the study watershed. The failed conservation structures play such a prominent role in causing land degradation particularly on those treated plots with *fanya juu* bund conservation measures and on those that are located below these plots. The original defectiveness of the structures, lack of care and subsequent damage, and lack of appropriate management are some of the factors that are related with the destruction of conservation measures and that might cause land degradation (Thomas Tolacha 1990). Several gullies that are caused by the improper construction of the *fanya juu* bund and considered by farmers’ of the study watershed as tobe “belonged to (or were caused by) the government” are numerous. This situation is also indicated by one earlier study in the neighbouring ‘*Chemoga’* watershed (Woldeamlak Beweket and Sterk 2002).

Various forms of water erosion can be seen every where in the highlands; for instance, sheet erosion, rill erosion, and gully erosion (Gete Zeleke 2000; Lakew Desta 2000; Belay Demissie 2000). Sheet erosion and rill erosion are by far the most widespread forms of erosion, and are more damaging to agricultural production than all other forms (Esayas Dagnew 2000). Currently, in addition to severe sheet and rill erosion, many parts of Gojjam, particularly cultivated and grazing lands are commonly seen dissected by gullies of different sizes (Gete Zeleke 2000). Gully erosion is the process that is affecting land degradation at a higher rate and it is likely responsible for the largest loss of cultivated land. The development of gullies has many negative impacts as it normally involves the loss of a great amount of soil. In fact, once a gully is formed it tends to further develop and there are very few chances that this process can be naturally reversed or, at list, halted. This results in a substantial damage to agriculture activities (Billi and Dramis 2000).

### *3.2. Farmers Perception of Soil Erosion in the Study Watershed*

Farmers of the study watershed are very well aware of the soil erosion problem. Asked whether erosion is a problem in their plot of land or not about 96.7 per cent of the respondents acknowledged soil erosion as a problem at least in one of their plots. In addition, asked whether the rate of erosion is increasing or decreasing on their plots of land, about 78.3 per cent of the respondents acknowledged that erosion is increasing on their plots. Again asked about the magnitude of the problem of soil erosion, about 71.7 per cent, 18.4 per cent, and 3.3 per cent of the respondents rated the magnitude as very severe, severe and moderate, respectively.

Table 3.4 Responses of the sampled households whether the rate of erosion is increasing or decreasing in their locality

| Rate of erosion | Percentage (%)* |
|---|---|
| Increasing | 78.3 |
| Decreasing | 15.0 |
| Same | 2.5 |
| Total | 95.8* |

Source: Own field survey, December 2001

* The percentages may not add to 100 due to repeated answers

The soil erosion problem is perceived by the majority of the respondents in terms of reduced productivity of land or decrease in soil productivity, gully encroachment or appearance on arable land; decrease the capacity of soils to grow a variety of crops which formerly used to grow, decrease in the depth of top-soil; decline in the water holding capacity of soils; and decline in yield from the farm.

Table 3.5. Farmers' perception of the presence of soil erosion

| Indicators of erosion | Responses(%)* |
|---|---|
| Gullies appear | 72.1 |
| Decrease in the capacity of soils to grow a variety of crops it Formerly grows | 53.0 |
| Decrease in the depth of top-soil | 44.2 |
| Decline in the water holding capacity of soils | 29.1 |
| Decline in yield from the farm | 67.3 |
| Soil productivity decrease | 48.2 |

Source: Own field survey, December 2001

* The percentages may not add to 100 due to repeated responses

Regarding the causes of soil erosion, most respondents mentioned steep slopes (68.1%), up land degradation (78.4%), and runoff from upslope(60.0%) as important causes of land degradation. Significant number of farmers (about 34.5%) also perceived up and downhill ploughing as a cause of soil erosion.

Table 3.6. Farmers' Identification of the causes of soil erosion

| Main causes of erosion | Responses (%)* |
|---|---|
| Land being on steep slopes | 68.1 |
| Too much rainfall | 53.8 |
| Soil too erodible type | 28.0 |
| Runoff from upslope | 60.0 |
| Upland degradation | 78.4 |
| Up and downhill ploughing | 34.5 |
| High density of livestock | 5.3 |
| Not applying land management measures, such as animal manure, crop rotation, etc | 29.5 |
| Others | 2.0 |

Source: Own field survey, December 2001

* The sum may not add to 100 % due to repeated responses

During the informal discussion it became clear that the current livestock stocking rate as well as the free grazing system in the study watershed are not considered as contributory factors for land degradation. The following testimony of my informants, from *Yedeme Gane Kidane Mihiret*, clarifies farmers' perception towards livestock as causes of land degradation. Asked about whether livestock aggravates land degradation in their locality or not the informants replied that" *…livestock are everything in our culture. Cattle, sheep, donkeys and horses provide draught power for land preparation, transport materials to and from the field, and to market, are important sources of manure to improve soil fertility of croplands, are important sources of additional household income to pay tax, for medication, etc, and above all they are important local indicators of wealth… Let them graze the hillside, they will provide manure for the cropland, provide dung for household energy… So, how dare you say, livestock are causes of land degradation. No, they are not*"(Old Key informant from *'Yedem Gane Kidane Mihiret*). This fact was also observed by Woldeamlak Bewket and Sterk (2002) in the neighbouring '*Chemoga'* watershed, where about 60%of the sampled farmers' did not consider livestock as a contributory factor for the current severe land degradation in the highlands.

### *3.3. Farmers' Perceptions of Soil Fertility Decline in the Study Watershed*

Farmers in the study watershed have their own way of describing and characterizing soils in their fields. They have developed a local system of soil classifications based on their experience of the potential and constraints of their soils. Farmers in the study watershed distinguished between five different soil types. The soils are locally known as *bonda, ashalema, borebore, borenke, and debayema*. These soils are classified on the basis of some recognized and easily identifiable soil and field characteristics. In the study watershed farmers' criteria for classification are yield, the topographic positions of the field [slope position], depth, colour, consistency, its fertility level, and the presence of stones [stoniness].

Table 3.3. The main characteristics of local soil types according to farmers response

| Characteristics | Soil type | | | | |
|---|---|---|---|---|---|
| | Bonda | Ashalema | Borebore | Borenke | Debaye |
| Colour | Black | Yellowish | Red | Yellowish | Black |
| Consistency | Mod-less sticky | Mod-less sticky | Less sticky | Less sticky | Very sticky |
| Depth | Deep | Ave-shallow | Ave.-shallow | shallow | Deep |
| Slope position | Plain | Hillside | Hillside | Hillside | Plain |
| Fertility condition | Less fertile | Less fertile | Mod.- Less fertile | Less fertile | Mod.- Less fertile |
| Stoniness | Not stony | Mod.- Very stony | Very stony | Moderate | Not stony |

Source: Own field survey, Dec. 2001
Mod.= Moderate
Ave. = Average

Farmers of the study watershed see soil fertility interms of soil's capacity for long-term productivity, its permeability, water holding capacity, drainage, tillage and manure requirement, and how easy it is to work. The farmers in the study watershed use various easily observable indicators to assess whether soil fertility is declining. The principal indicators they mentioned is reduced crop yield. In addition, they mentioned the appearance of some weeds species, like *Mech* (Gizatia scabre), *Adyo* (Carcopsis spp.), *Asendabo* (Setaria verticulate), *Sinar* (Avena abyssinica), *Engcha* (Strychmos innocua), *Gortebe* (Plantage spp.), *Lute or Strungig* (Rumex strou delili), etc., as indicators of soil fertility decline. However, though their presence might be considered as an indicator of the decline of the fertility of soils this may not always hold true as their presence may "reflect cropping practices rather than soil conditions"(Corbeels et al 2000). That is the ability of weeds to act as unambiguous indicators of the soil conditions, i.e., the fertility situation of soils is still not clearly known or is limited.

## CHAPTER-IV

## 4. AGRICULTURAL LAND MANAGEMENT IN THE STUDY WATERSHED

Different types of land management practices [both indigenous and 'conventional' ones] that are practiced by the framers are explored in this part of the study. Different field level data, i.e., household survey, on-farm observation, discussions with Wereda office Agriculture (WoA) conservation experts as well as Development Agents (DAs), and group discussion with farmers' of the study watershed are employed to generate the required data. In addition, secondary sources are also consulted to substantiate the analysis.

### *4.1. Indigenous Land Management practices in the Study Watershed*

Different indigenous land management measures that are well adapted to local conditions have been practiced in the highlands of Gojjam. In the study conducted in Digil watershed, two types of indigenous land management practices have been observed. These are household-level, and supra-household level (neighbourhood level and community-level) land management practices.

*A. Household-level land management practices*

The household-level land management practices include those land management measures that are practiced and/or managed by a single household, and are both protection as well as production oriented. These measures are usually practiced at croplands owned by a single household. Each household has got fragmented plots in different locations with different biophysical characteristics (slope, soil, agro-climate, etc), and each plot holds plot-specific problems and possibilities. Therefore, households make different land management strategies as well as decisions at household level for each plot they own. From these household level indigenous land management measures, some are soil conservation measures while others are fertility management measures. Traditional ditches (*feses*) are important household-level soil conservation measures in the study watershed. In addition, fallowing, manuring, animal parking, Ley cropping (Cropping *'gibto'* or *Lupines lupine*), weed heaping, crop rotation, etc., are some of the soil fertility management measures that are widely practiced at household-level in the study watershed.

*B. Supra-household level land management practices*

*i. Neighborhood level*

Some land resources might be managed jointly by two or more land users. In the study watershed, there are land management practices that are constructed as well as managed and/or maintained by two or more neighbouring land users'. Usually they are constructed or implemented on two or more neighbouring croplands, which are owned by different households. In this case the decision on what should be done along shared field boundaries or on adjacent plots is taken on the basis of a mutual understanding of the land users'. These measures are more of conservation or protection–oriented, and include traditional cut-off drain *(tekebekeb or trass boyi*), traditional waterways *(Bahelawi Boyi)*, and unploughed strip *(dinber)* which are designed, constructed and maintained together.

*ii. Community –level land management practices*

This is commonly observed on communally owned land resources, such as grazing land and common woodland. Decisions about how to manage these resources are taken by the community. Such experiences are also observed by some authors in Southern Welo and North Shewa where the community manage common grasslands through controlled grazing (Yohannes G/Michael and Herweg 2000). This controlled grazing practice [locally known as *'kelekele sare'*] is currently strictly practiced by the community of the study watershed due to the increasing degradation of the communally held or owned grazing lands.

### *4.1.1 Indigenous Soil Conservation measures*

Farmers' in the study watershed have been practicing certain combinations of physical/structural, biological and agronomic methods of soil conservation.

*Physical/Structural Conservation measures*

*Traditional ditches ('feses')*

Traditional ditches (*'feses'*) are the widely practiced household-level structural soil conservation measures in the study watershed. They are structures built with the ox-plough, and are deeper than the normal furrow (Million Alemayhu 1992,2001;Yohannes G/Michael and Herweg 2000). Almost all farmers in the study watershed use traditional ditches (*'feses')* at least in one of their cultivated plots depending on the type of crop cultivated. During the field survey farmers were asked whether they use traditional ditches on their plots, and if so for what purpose. Surprisingly enough, all of them answered 'yes'. They said that traditional ditches have been used since long ago for three reasons: (1) as a measure to decrease seed loss, particularly those cereals of fine seed, such as *teff*, (2) as a measure to protect soil from erosion, and (3) as a measure to decrease waterlogging problems. As it was observed during the fieldwork and confirmed by farmers' of the study watershed these structures are structural soil conservation measures. However, the findings of some other authors (see Belay Tegene, 1998a) does not coincide with this fact as the structures are considered as simply drainage ditches which rather facilitate the process of soil erosion than soil and water conservation structures.

Traditional ditches are constructed in every cropping season using a '*maresha'* plough, which is drawn by a pair of oxen after final land preparation. They are mainly constructed and maintained by family labour. The gradient, number, spacing, depth, width and even function of the traditional ditches on cultivated land differ from farmer to farmer, from plot to plot, and even from crop type to crop type. Though it may vary from plot to plot the width of the ditch is usually determined by the width of the ox-plough. During the informal discussion with farmers it became clear that the width of the ox-plough used may vary from plot to plot depending on the depth of the soil. The same is true regarding the width of the traditional ditches *('feses')*. In his study in North Shewa highlands Million Alemayehu(1996) reported that the width of the traditional ditches may vary from 30-50 cm. In addition, it became clear that the depth of plough layer of the soil usually determines the depth of the traditional ditches. Therefore, as the depth of the plough layer varies from one plot to the other the same is true in the case of the depth of the traditional ditches. Of course, they are generally deeper than the normal furrow. In his study in North Shewa highlands, Million Alemayehu(1996) reported that the depth of the traditional ditches varies from 5-20cm.

The gradient, the spacing and the length of the traditional ditches also vary from plot to plot and from farmer to farmer. The spacing of the ditches is dependent on the steepness of the slope, where steeper cultivated land has more traditional ditches than cultivated land on gentler slopes. The gradient of the cropland treated by the traditional ditches ranges from 2% to above 50%. However, traditional ditches are also used on almost flat and waterlogged land as a measure to decrease waterlogging problems. The length and/or width of each farmer's cultivated land determine the length of traditional ditches. The length and/or width of traditional ditches is proportional to the length and/or width of the cultivated land, i.e., it extends from one side of the plot to the other side (locally known as '*gezem eske gezem'*).

Though traditional ditches are constructed on the cultivated field every cropping season, they are not constructed on the same place like that of the 'conventional' physical conservation measures, *the fanya juu bunds*. Farmers' vary the position of the traditional ditches in order to avoid a gradual widening and deepening over time. So that "when the cultivated land with traditional ditches is put to fallow after the harvest, the ditches will not develop into a gully as it has already been stabilized and the grass and other vegetation will cover it during the fallow period" (Million Alemayehu 1996). This is one of the strengths of these conservation measures.

*Construction of Stone terrace*

This structure is observed in only a few plots in *Zhega Mera Yetsed kebele*. It is constructed in areas where the construction material (stone) is available and considered tobe effective in protecting the soil from erosion. However, the measure is labour intensive, as it requires require much input of family labour for construction and maintenance and needs good construction and maintenance skill.

*Traditional Cutoff drain ('tekebekeb')*

This is one of the neighbourhood-level indigenous physical soil conservation measures though it is primarily constructed for drainage sake as well as to protect seeds from loss. The structures are constructed diagonal to the traditional waterways prepared on plots parallel to the slope, immediately after sowing seeds. By doing so farmers' also protect soils from loss.

*Traditional Waterways ('Behalwi Boyi')*

This waterway is prepared at the top of the slope like cutoff drain. It is constructed and/or managed either by neighbours or by the community at large. Its function is to drain the water coming from any direction to the nearest riverbank. By doing so it protects croplands from soil erosion.

*Contour Ploughing*

Contour plouighing is the other indigenous soil conservation measure that is currently extensively applied in the study watershed. When the land is ploughed horizontally, the contour furrows serve to hold rainwater until it infiltrates, and by doing so they moderate the eroding effects of surface runoff. Its function is multiple, i.e., it conserves soils by holding water until it infiltrates. However, this measure has limitations; that is, it is not very effective in areas where the rains are intensive and the slopes are long and steep (Belay Tegene 1998a). In addition, it became clear from the group discussion with the farmers' that the contour furrows are finally destroyed during the final ploughing and fine seedbed preparation for sowing fine seeds, like *teff*. So, fine seedbeds without adequate crop cover are exposed to the direct effects of raindrops during the months of heavy storm June, July and August, and then affected by soil erosion. This clearly indicates that the benefits of contour furrows as a soil conservation measure are lost during the growing season, particularly on croplands of fine seed cereals.

### *4.1.2 Indigenous Methods of Improving Soil Fertility*

Pool of soil fertility management practices were/are extensively practiced by farmers' of the study watershed. During the group discussions farmers were asked to describe how they try to improve soil productivity. And the following measures are mentioned as important indigenous soil fertility management measures that have been practiced so long in the area.

*Fallowing*

Farmers in the study watershed explained that fallowing used to be the most important way of improving soil fertility during the 'old-good days.' According to farmers', yields from a cultivated land might decline if the land continuously grow crops without any fallow period.

So that, the land was left uncultivated for two to three years to give it sometime to recuperate its fertility. However, during the field survey it became clear that this practice has become the tradition of the past. Due to population pressure and the resulting land shortage the method is not currently extensively applied by the farmers of the study watershed. Rather they shift their fallowing system from pure fallowing, i.e., leaving the land ideal for two or more years in to 'seasonal fllowing' and/or 'improved fallowing'. The most common seasonal fallow now practiced in the study watershed is growing 'gibto' or *Lupines lupine.*

*Crop rotation*

It is one of the most important means of improving soil fertility as well as conserving the soils of the study watershed. It is a "system by which nitrogen restoration is attained by alternating different types of crops on the same cultivated land". This practice is considered to be very effective in maintaining the nitrogen status of the soils where leguminous plants are included in the rotation (Belay Tegene 1998b).

Farmers are well aware that they can improve soil productivity by rotating crops. According to farmers, they usually rotate crops on their fields particularly on those fields that are located away from the homesteads and receive very little manure. Farmers choice of which crops to grow in rotation are largely based on their personal preference as well as suitability of the soil type used by farmers for the chosen crops. Similarly, a study conducted in Tigray indicated that farmers choose which crops to grow in rotation according to how they adapt to the soil and the rainfall pattern as well as economic consideration such as the price of the crops to be chosen (Corbeels et al 2000). The major crop rotations practiced are from cereals to cereals [Barely-wheat-barely or Teff-barely/wheat-teff], from cereals to legumes [Barely-chickpea-barely], or from cereals to oil seeds [Teff-noug-teff].

Most farmers believe that starting the rotation with cereals and then planting legumes improves crop productivity more than rotations based solely on cereals. However, crop rotations in the study watershed are dominated by cereals, i.e., legumes are currently out of the rotation. The main reason given by farmers' in relation to this situation was that they give priority for subsistence crops or cereals to feed their family using the available small and fragmented plots. This trend is also observed by other author (see Belay Tegene 1998b) in South Welo. According to the report such practice may ultimately lead to sever soil fertility depletion and productivity loss since very little nitrogen can be fixed in the absence of leguminous crops. Farmers in the study watershed are also knowledgeable about the relationship between crops and soil types, and said that some crops influence the productivity of certain types of soils. They usually grow crops that have a similar effect to "improved fallowing" (for example, *Lupines lupine* or '*gibto'*) in order to improve fertility of soils. Improved fallowing in this case refers to a practice in which "legumes or other crops/trees are planted during the fallow and not harvested for the purpose of improving soil quality"(Mulder 2000).

*Manuring*

Manuring used to be an important input for maintaining and enhancing soil fertility. It was practiced through animal parking or *'temporary kraal' or 'chichet'*. Currently, farmers apply only limited amounts of manure on their fields as the relatively small number of livestock per household limits the amount of dung available. In addition, the fragmentation of the land is mentioned as one of the most important factors that hinders the application of manure. This is because it becomes expensive (as the manure from livestock owned by a single household may be very small) and labour intensive as transporting it to fields far away from the homestead demands much labour which cannot be afforded by a single household. Moreover, manure (dung) is often used as fuel. This is primarily because farmers burn dried cattle dung as a source of fuel instead of using it as organic fertilizers, due to the severe shortage of fuel wood (see Belay Tegene 1998b).

*Weed heaping*

Farmers in the study watershed enrich their soils by uprooting and heaping weeds. Farmers usually incorporate grasses and weeds into the soil as green manure. Nowadays, this measure is not extensively practiced as most farmers use grasses and weeds as a fodder for livestock due to the degradation of the communal grazing lands.

*Cropping 'gibto' (Lupines lupine)*

The majority of the informants covered by the survey confirmed that they have been practicing various cropping methods at various scales. The most important cropping practice observed in the study watershed is cropping "g*ibto*" (*Lupines lupine*). Farmers noted that when the productivity of a given cropland declines they grow 'g*ibto*' on that plot. Doing such activity has several advantages. Firstly, growing '*gibto'* dose not require too much ploughing and preparation of fine seedbed like other cereals. Secondly, *Lupines lupine ('gibto'*) has a nitrogen fixing effect (Communication with WoA conservation experts and DAs). Thirdly, the crop does not require as much moisture as other crops do. In addition, cropping this crop and leaving it on the land in order to improve the fertility of the land may not cost farmers too much. That is, the market price of the crop is very low, estimated 10-15 Birr/Quintal.

Inter-cropping and cover cropping are the other most commonly used methods both for soil conservation and soil fertility management. For instance, during the survey some farmers mentioned that they usually combine cereals, root crops and different types of legumes. Of course, this practice seems to be "unintentional intervention" by farmers to protect the soil from erosion by giving it cover as well as improving its fertility condition (Belay Tegene 1998b). Nevertheless, inter-cropping ensures the soil coverage and protects it from rains so that the soil particles may not be disintegrated and washed by erosion.

### *4.2 The 'Conventional' Land Management Measures*

#### *4.2.1 The 'conventional' soil conservation measures*

The 'conventional' conservation measures that are newly introduced and widely applied on cultivated fields in the study watershed are the *fanya juu, construction of check dams or 'kiter' and construction of waterways*.

A *fanya juu* bund is made by digging a trench and throwing the soil uphill to form an embankment. *Fanya juu* terraces are sometimes called converse terraces. According to literatures, *fanya juu* terraces are very popular on smallholder farmers particularly in semiarid areas where they are very effective in conserving moisture and nutrients. They are applicable in areas where soils are too shallow for level bench terracing and on moderately steep slope areas (e.g, below 20%). They are not suitable for stony soils (MoALDM 1997). It is believed that well maintained *fanya juu* terraces can develop into level bund through time

*Construction of Diversion ditches or cutoff drains*

The other 'conventional' soil conservation measures that are currently practiced in the study watershed are construction of diversion ditches or cutoff drains. Diversion ditches are graded channels with a supporting ridge or bank on the lower side. They are constructed across a slope and are designed to intercept the runoff and convey it safely to an outlet such as waterways. They are used to protect cultivated land from uncontrolled runoff and to divert water away from active gully heads. It is intended to protect cropland against runoff from adjoining non-arable land, it should be constructed at the boundary between the two. From the 'conventional' soil conservation structures introduced to the study watershed, these measures seem to be more preferable by farmers as they are more or less similar with the traditional cutoff drain interms of function. The major limitation of this measure is that it is aligned straightforward so that it may have to cross croplands belonging to different farmers

*Construction of Waterways*

Waterways are structures needed to conduct runoff safely from hill slopes to valley bottoms where it can join a stream or river. These waterways are more or less similar with the traditional waterways (*Bahlawi Boyi*). Farmers' of the study watershed usually prefer to have one big waterway than to have several small waterways as it is considered as space saving.

*Construction of check dams*

Gully encroachment or gully erosion is one of the serious problems of the study watershed. So that in order to mitigate or minimize the problem different gully reclaiming or stabilization measures are currently being conducted in the watershed. Gully stabilization involves the use of appropriate structural and vegetative measures in the head floor and sides of gullies. In the study watershed, particularly in the *Digil* Watershed on-farm trial site which is located in *Melite Mariam*, two methods of gully stabilization have been observed. The first one is use of vegetation, that is, allowing the gully to re-vegetate naturally by keeping the livestock away from the gully areas or gully sides. This measure is more or less similar with area closure for natural regeneration of vegetation in order to stabilize the gullies. This method is cost effective as well as less labour intensive. However, it takes long time for recovering the gullies if the soil is poor.

The other structural method practiced in the study watershed for gully stabilization and/or gully rehabilitation is construction of checkdams *('kiter')*. They are constructed across the floor of a gully to slow the runoff and trap sediment. They facilitate the establishment of vegetation, which will eventually stabilize the gully and protect it from further erosion. Farmers' of the study watershed again do have positive attitude towards the construction of these structures since they are considered as efficient in rehabilitating and/or protecting the soil from erosion

#### *4.2.2 The 'Conventional' Soil Fertility Management Practices*

DAP and Urea are the two most important artificial fertilizers that are widely applied to improve soil's fertility. At present, the MoA is implementing the Participatory Agricultural Demonstration and Training Extension System (PADETS), which in 1995 adopted Sasaakawa Global 2000 approach. This programme focuses on a package of mineral fertilizer, pesticides and improved seeds for strategic crops, such as maize and wheat(Lakew Desta et al 2000).

Farmers were keen to use mineral fertilizers. Asked whether they use artificial fertilizer or not about 86.7% and 4% of the sampled farmers' responded 'yes' and 'no', respectively. The remaining (6.7%of the sampled farmers) did not respond 'yes' or 'no' for they could be sharecroppers. In addition, asked about how they get artificial fertilizer nearly 78% of the respondents asserted that it is obtained through loan or on credit basis. Farmers repeatedly raised its relatively high price, lack of credit, and untimely and inefficient supply as the major constraints on the use of fertilizers. Of course, since fertilizer is sold at market price it is not really financially viable for many farmers of the study watershed. Moreover, the application rates may vary from farmer to farmer depending on the farmers' economic status. Though the households income has not been assessed, it was learned from the group discussions with the farmers' that the richer farmers buy the most fertilizers, while virtually all the non-users come from the poorer socio-economic groups. Poor farmers may buy very little amount of fertilizer from the local market and apply it carefully to small areas. Generally, it was noted that their utilization levels are significantly less than the officially recommended dose of 100-kg DAP/ha and 50 kg Urea/ha (Communication with DAs).

CHAPTER-V

## 5. LINKING THE INDIGENOUS WITH THE 'CONVENTIONAL' MEASURES FOR SUSTAINABLE LAND MANAGEMENT

Pool of land management practices were/are practiced by farmers of the study watershed. Farmers are with rich indigenous land management practices. Some of the major ones can be revitalized and integrated in to the 'conventional' measures initiated by interventionists in order to bring sustainable land management in the watershed. Though the farmers apply different land management practices since long-time, the problem of land degradation has not been solved or minimized. Rather, it continuous unabated.

Understanding the problem, different 'conventional' land management measures have been introduced, mainly by the government. However, the introduced 'conventional' measures seem to be not accepted and extensively applied by the farmers' of the study watershed. Instead, farmers' continue practicing their own indigenous land management measures though the problem is unabated and agricultural productivity is not enhanced. Understandably, as this fact shows, there is an urgent need to critically assess the merits of the two measures and link them purposefully in order to bring the desired outcome, i.e., solving the problem of land degradation and bringing sustainble land management. But the question is how these measures can be complimented each other in a purposeful way in order to bring sound and lasting solution. Several steps are there. First, in order to link these measures the factors that affect farmers' decision to invest on land management activities as well as their decision on the choice of land management measures should be explored. Secondly, the merits and demerits of both [indigenous and 'conventional'] measures should be assessed. And then, taking a lesson from their merits, the measures can be purposefully complimented in order to meet the desired objective.

### *5.1 Factors Affecting Farmers Decision to Invest on Land Management Activities and Their Choice of Land Management Practices*

The analysis of what factors affect farmers decision to invest on land management activities and which measures they do/do not choose to manage their land is a very tough business. However, in this section attempt has been made to explore the factors that affect farmers' decision to invest on and their choice of land management practices from farmers' point of view.

#### *5.1.1 Land Related Factors: Land Holding Size; Land Fragmentation; Land ownership*

During the group discussions, farmers identified a set of land related factors that affect [positively and/or negatively] their decision to invest on land management as well as their choice of land management practices. The sampled farmers of the study watershed indicated land-holding size, land fragmentation and land ownership as important land related factors.

As it is argued, farmers decisions to investment on land management activities as well as their choice and implementations of land management practices are affected by tenure security. Some argue that private ownership is vital for it encourages farmers to invest on as well as choose appropriate or efficient and lasting land management practices (see Yeraswork Admassie 2000; Belay Tegene 2000a). On the other hand, others argue that private ownership of land can be considered as an incentive towards sustainable land use and /or sustainable land management rather than a necessary condition, and hence it may or may not affect farmers decision to invest on land management and their choice of land management practices (see Woldeamlak Bewket and Sterk 2002).

Given the above arguments, attempt has been made to see what the farmers of the study watershed feel about the security of land tenure and its implications on their decision to invest on and choice of land management practices. Asked about their feeling towards future land redistribution, over 48 per cent of the total respondents feel insecure in their present day land holding and do have fear that they may lose their holdings in the future redistribution. However, about 46.2 per cent of the respondents' feel that they are not going to lose their holding during the future redistribution, rather they are hoping to get additional land. Of course, the latter group was complaining on the 1997's land redistribution that was conducted by the Region's government. Therefore, the positive feeling or hope of getting additional piece of land from the coming redistribution may emanate from their dissatisfaction on the former land redistribution. And the remaining 5.4 per cent of the respondents were not interested about the issue. Moreover, during the informal discussion it was understood that most farmers' have less interest to spend time and energy on long term improvement activities like tree planting and construction of terraces and bunds on their farmland for land management sake. They said that if they do so they may lose their trees and fertile land in the coming round of land redistribution. Hence, from the above observation it appears clear that absence of land ownership security, besides the neglect of the indigenous knowledge of land users, is found to be the most important factor that can deter an individual farmer from investing on as well as choosing and applying sound and lasting land management practices, and even willingly accepting and participating in the construction and maintenance of the newly introduced and widely applied conservation structures, the *fanya juu* bunds.

The size of land holding of an individual farmer in the study watershed is one of the smallest. The average land holding size of the sampled households is about 1.39 ha. The size of farms range from 0.5 ha to3.0 ha.

Table 5.1 Land holding size of the sampled households

| Land holding size(ha) | Percentage(%) |
|---|---|
| 0.50 - 1.00 | 51.7 |
| 1.10 - 1.50 | 10.7 |
| 1.51 - 2.00 | 13.8 |
| 2.10 - 2.50 | 8.6 |
| 2.51 - 3.00 | 5.2 |

Source: Own Field Survey, December 2001

Like that of land tenure security land holding size has also significant bearings on farmers' decision to invest in land management practices as well as their choice of land management methods. For instance, a decreasing land holding size was mentioned as a cause for the decline in the practices of certain indigenous fertility management practices, such as fallowing and the shift to other types of indigenous fertility management practices like cropping or Ley cropping. Moreover, this situation has made farmers' to be reluctant on applying space taking soil conservation measures. If they feel that the measure is space taking, they become reluctant to accept and implement the measures on their plot. This indicates that as land becomes increasingly scarce or landholding size decreases, farmers become more aware of the need to make the best use of the land through choosing appropriate management practices.

Asked about the effect of land fragmentation on their decision to invest on and choice of land management practices, the majority argue that it has an adverse effect. For instance, as a result of land fragmentation many fields become far from the homestead, which makes transporting dung to these fields a time-consuming and labour intensive operation, frequent visit and maintenance of traditional ditches *('feses')* after heavy storms as cumbersome task. Therefore, land fragmentation may have an adverse implication on farmers' decisions to invest on land management practices as well as their choice of land management measures.

### *5.1.2. Livestock Size*

Livestock is the major component of the agricultural system of the study watershed. The types of livestock that are being reared by the sampled households include cattle, sheep, goat, mule, donkey and poultry. It must be noted that draught oxen ownership and livestock size are important wealth indicators. The wealth status of farmers also seems to have a significant impact on the ways as well as the choice of methods by which farmers manage their land. During the informal discussion with farmers of the study watershed it became clear that those who are considered as 'wealthy' farmers or farmers with livestock had access to more manure, and implement more soil fertility management practices than other farmers do, given that they do have adequate household or family labour. Even practicing other traditional land management practices such as traditional ditches or *'feses'* requires or directly dependent on these resources. In other words at least a pair of oxen with a simple ox-plough is required to implement these measures. The existence of such direct relationship between traditional land management practices and livestock ownership has also been observed by other authors in the northern part of the country (see Corbeels et al 2000; Belay Tegene 2000a; 1998b).

Table 5.2 Livestock ownership of the sampled households

| Number of Livestock | Livestock Owners (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ox | Cow | Heifer | Calf | Goat | Sheep | Donkey | Horse | Mule | Poultry |
| No livestock | 11.7 | 25 | 45 | 60 | 88.3 | 40 | 48.5 | 85.7 | 90.0 | 87.0 |
| 1 | 30.0 | 38.3 | 36.7 | 25 | 1.7 | - | 45.6 | 12.5 | 3.3 | 5.6 |
| 2 | 48.3 | 20.7 | 15.8 | 11.7 | 1.7 | 8.3 | 3.5 | 1.8 | - | 5.6 |
| 3 | 5.0 | 6.7 | - | - | 3.3 | 16.7 | - | - | - | 1.9 |
| 4 | 1.7 | 6.7 | - | - | 1.7 | 11.7 | - | - | - | - |
| 5and above | - | - | - | - | - | 18.3 | - | - | - | - |

Source: Own Field survey, December 2001

### *5.1.3. Production Assets or Farm Implements Ownership*

In subsistence agriculture, farm implements are few in number, simple in kind, smaller in size, and crude in character. Likewise, Ethiopian agricultural implements are traditional, simple and 'inefficient' in ploughing the land. The majority of the farm implements used by the sampled households of the study watershed are also traditional, simple and 'inefficient' in ploughing the land. The farm plow as a whole is driven by a pair of oxen and in some cases by an ox and a horse in the study watershed (mainly in *Zhega Mera Yeted Kebele).* According to the investigation, there are farmers who do not have even complete basic farm implements. Complete basic farm implements include *Kember* (wooden yoke), *Mofer* (wooden beam), *Maneko*(double wooden neck), *Maresha* (iron-tipped plough), *Digr*( wooden wings), *Miran* (leather strip), *Wogel* and *Tefer* (B-shaped iron piece and leather to adjust distance between *Maresha* and beam), *Mached* (sickle), *Menshe*(fork-shaped wood), etc (Mengistu Woube and Workneh Negatu 2000). This situation has again an adverse effect on the land management activities of farmers.

Table 5.3 Production Assets Ownership of the Sampled Households of the study watershed

| No | Number of production asset owners* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IP | Yo | PB | SH | SI | SA | HO | AX | BU | FA | RA | JE |
| 0 | 5 | 7 | 6 | 30 | 3 | 53 | 21 | 16 | 58 | 58 | 53 | 50 |
| 1 | 43 | 36 | 16 | 24 | 17 | 3 | 34 | 32 | - | - | 5 | 4 |
| 2 | 10 | 15 | 30 | 4 | 24 | 2 | 1 | 7 | - | - | - | 1 |
| 3 | - | - | 4 | - | 10 | - | 1 | 1 | - | - | - | - |
| 4 | - | - | 2 | - | 4 | - | 1 | 1 | - | - | - | - |
| 5 | - | - | - | - | 1 | - | - | 1 | - | - | - | - |

Source: Own field survey, December 2001

* Some of the sampled households did not respond to this question, so that the sum may not be equal to the total number of the samples

Key: IP=Iron Plough , YO= Yoke, PB= Plow Beam, SH= Shovel, SI= Sickel, SA= Saw, HO= Hoe, AX=Axe, BU= Butagase, FA= Fanos, RA = Radio, JE= Jerican

### *5.1.4 Labour Availability*

The availability of family labour is one of the most important pre-conditions for the successful implementation of conservation measures by farmers. Almost all informants indicated that they depend on family labour for both agricultural activities and conservation tasks although there are other types of labour arrangements, like share cropping.

Table 5.4. Household size of the sampled households

| Household size | The sampled households | |
|---|---|---|
| | Frequency | Percentage |
| 1 | 1 | 1.7 |
| 2 | 7 | 11.7 |
| 3 | 6 | 10.0 |
| 4 | 11 | 18.3 |
| 5 | 7 | 11.7 |
| 6 | 6 | 10.0 |
| 7 | 7 | 11.7 |
| 8 | 8 | 13.3 |
| 9 | 2 | 3.3 |
| 10 and above | 5 | 8.4 |
| Total | 60 | 100.0 |

Source: Own Field survey, December 2001

## *5.2 The Strengths and Problems of Land Management Practices*

Understanding the strengths and problems of the land management practices [both the indigenous and the ‘conventional’] can assist in identifying the criteria determining farmers use of different land management practices that are economically viable and socially acceptable. Therefore, an attempt has been made to assess the strengths and problems of both the indigenous and the ‘conventional’ land management practices that are practiced in the study watershed.

### *5.2.1 The Strengths and Problems of the Indigenous Land Management Practices*

As agricultural land management is the actual practice of the use(s)of land by the land users, understanding the strengths and problems of the users' [farmers'] land management system is indispensable to implement sustainable land management practices. In addition, understanding the strengths and problems of the indigenous land management systems of the land users may reveal important clues for the development of alternative sound and sustainable land management systems. Therefore, it is important to critically assess both the strengths and problems of the measures.

Most indigenous land management practices [both soil conservation and soil fertility improvement] are characterized by several strengths, such as multi-functionality, multiple benefit, flexibility, low external input dependence, compatibility to the farming systems, etc.

(a) Multi-functionality and Multiple-benefits

Their multiple functions and multiple benefits characterize most indigenous land management practices. These multi-functionality and multiple benefits of the indigenous land management practices are the reflections of the basic strategies developed by the land users' in response to the great variability of biophysical and socio-economic conditions. For instance, crop rotation, one of the most widely applied soil fertility enhancing measures in the study watershed, has a number of functions as well as benefits to the farmer. It improves the soil fertility, controls the spread of weeds and insects. Other previous studies in South Welo (see Belay Tegene, 1998b, 2000) also support this finding. In addition, the indigenous structural conservation measures, i.e., traditional ditches or *'feses'*, do have multiple function and multiple benefits. They have been used since long ago as a measure to decrease seed loss, as a measure to protect soil from erosion, and as a measure to decrease waterlogging problems. Being an integral component of land management and cropping systems they are space saving. Similarly, these multiple benefits of indigenous land management measures are also observed in the indigenous conservation structures of South Welo, *Weber*, where the structure is used as a control of runoff and soil erosion as well as for the production of high quality grass for plough oxen and for thatching roof and to provide fertile soils (see Belay Tegene 1998a). Inter-cropping and cover cropping are the other most commonly used methods for both soil conservation and soil fertility management. Inter-cropping ensures the soil coverage and protects it from rains so that the soil particles may not be disintegrated and washed by erosion. Moreover, it improves the fertility status of soil.

(b) Flexibility

Flexibility is the other fundamental characteristic of some of the indigenous land management practices. Since they are flexible, they can be easily adapted to changing biophysical and socio-economic conditions. For instance, farmers usually change the position of the traditional ditches in order to avoid a gradual widening and deepening over time so that the ditches will not develop into a gully. In addition, the gradient, number, spacing, depth, width and even function of the traditional ditches on cultivated land differ from farmer to farmer, from plot to plot, and even from crop type to crop type. These clearly reveal the flexibility of traditional ditches.

(c) Efficient in labour Utilization

Though it is not true in all cases, low labour requirements as well as efficiency in labour utilization characterize most of the indigenous land management practices. In small-scale farming system, soil conservation measures, particularly structural soil conservation measures are not built in one go but gradually. They are developed on " incremental basis over many years"(Belay Tegene 1998a). Therefore, this spreading of labour requirements for construction and maintenance helps to reduce peak times and labour shortage.

Soil conservation measures mainly traditional ditches or *'feses'* are integral part of the farming system. Therefore, they do not require additional or extra labour input. Moreover, some of the structures like the traditional waterways ('*behalawi boyi'*) and the traditional cutoff drains ('*tekebekeb*') are constructed and maintained by the neighbours or the community at large. Therefore, they do not exert pressure on the household's labour. Rather, they facilitate cooperation between and/or among farmers so that there will not be shortage or problem of labour.

(D) Compatibility to the farming system

One of the features of the indigenous land management practices is their compatibility to and high integration with the current farming systems. The process of developing indigenous land management practices reflects the degree of integration of these measures into the farming system. That is, the construction and maintenance of the indigenous land management may not happen apart from the prevailing farming practices. For example, construction and maintenance of traditional ditches, weed heaping, inter-and cover-cropping, etc. are part and parcel of the prevailing farming systems of the study watershed. This finding is supported by the findings of other authors in South Welo(see Belay Tegene 1998a), where the initiation of grass strips, *Weber*, is made during ploughing. The same is true in the case of the improvement of the fertility status of the soils. Farmers usually grow a variety of crops on the same plot of land at the same growing period, i.e., they apply inter-cropping, multiple-cropping, etc. These practices provide a variety of products as well as improve the fertility of the soil. Generally, these land management practices of the study watershed are highly integrated into the prevailing farming systems and serve both production and protection purposes at the same time.

(e) Low external input dependence

Indigenous land management practices do not demand import of materials as they are depending only on locally available resources. Their construction and maintenance using locally available tools and materials, the ox plough and human labour characterize most indigenous land management practices. For instance, the practice of inter-and cover-cropping, crop rotation, manuring, fallowing, as well as the construction and maintenance of the physical soil conservation measures may not demand external input. As it is reported by other research findings (Belay Tegene 1998b) most indigenous land management practices "do not depend on imported knowledge and managerial skills since these methods are familiar to the local farmers and thus, can be easily implemented by the farmers themselves"

Another characteristic that makes traditional land management practices attractive to the farmers is their low financial requirement and their complimnetarity. For example, cropping *'gibto' (Lupines lupine*) dose not cost farmers too much. Moreover, most indigenous land management practices are complimentary to each other with in a particular plot. For instance, different agronomic and physical/structural conservation measures that are applied on a given plot complimentary to each other.

Some of the indigenous land management measures also have some limitations. For instance, fertility management practices such as manuring require more labour force to transport the manure to fields that are located long distance away from the homesteads which is by far beyond the capacity of most individual families. Moreover, the physical soil conservation measures, such as traditional ditches, traditional cutoff drains and traditional waterways may aggravate soil erosion in areas where they are ill-designed. However, this is not the case observed in the study watershed. That is, indigenous conservation measures induced erosion features were not observed and even reported by farmers during the survey. On the other hand, the *fanya juu bund*-induced erosion features were observed inside and near the *fanya juu* treated on-farm trial site of the *Digil* watershed.

### *5.2.2 The Strengths and Problems of the 'Conventional' Land Management Practices*

Though it is a bit difficult to assess critically the strengths of the 'conventional' land management measures, some problems have been observed from the very outset of their introduction.

The *fanya juu* bunds

Regarding the *fanya juu* bunds most farmers of the study watershed seem to be not interested on the construction of the structure on their plots. Even the already constructed ones seem to be constructed through coercion or 'stick-and-carrot approach'.  Asked about why they dislike the structures, the majority said that (1) they create obstacle to the turnover of yoked pair of oxen during ploughing, (2) they are space taking, and (3) they are not designed to suit local farming system. Faced with shortage of farmland, the majority of the local farmers plough right upto the conservation structures. This situation is also observed by Woldeamlak Bewket and Sterk(2002) in north-western highlands and Thomas Tolacha(1998) in the highlands of Hararghe. In addition, their ill-design may cause overtopping of runoff from conservation structures, and hence further aggravates soil erosion rather than soil conservation. The added limitation of the *fanya juu* bunds is that they are not constructed on the basis of 'real field situations'. That is they are constructed on the basis of "guidelines of manuals prepared in reference to slope inclinations and categorized by agro-ecologies, and are generally considered to insensitive to microscale biophysical and socio-economic realities" (Woldeamlak Bewket and Sterk 2002). Generally, farmers seem to be not willing to participate on the construction of the *fanya juu* bunds on their plots of land. Farmers also noted that the structure is labour intensive and probably may not be done by a single household.

Moreover, farmers reported that the conservation structure may be a potential fertile ground for conflict between and/or among neighbors because it is not constructed as well as maintained by the neighbours or the community at large for mutual benefit on the basis of their mutual understanding. Asked about why they consider the *fanya juu* bunds as a potential fertile ground for conflict between and/or among neighbours, the farmers of the watershed said that*: "had it been traditional waterways (Bahlawi Boyi) or traditional cutoff drain (tekebekeb), we would have agreed on how and where to drain the runoff, We would have designed the structure together. However, in the case of the fanya juu bunds, the design is made by the DAs (agents of the government) without consulting and/or participating us. In addition, we all assume it belongs to the government. So that, we do not bother about its maintenance and the way the runoff is properly drained without affecting the neghibouring cropland* "(Group discussion with farmers). In addition, it was also noted that the structure may not suit the free grazing system of the study watershed since it can be easily damaged by livestock after harvest and even its maintenance will again demands extra labour and time that can not be afforded by a subsistence farmer. It is all these factors that may discourage farmers accept/adopt the measure.

The measures are not as multi-functional as that of the indigenous land management measures. They are often meant for a specific function, i.e., for soil conservation only. Moreover, being a 'standard' solution, they are considered to be inflexible [interms of shape, size, gradient, and length] as well as not compatible with the prevailing land use and farming systems of the study watershed. Moreover, since the measures are labour intensive [, i.e., require too much labour for construction and maintenance] they could not be easily integrated to the prevailing farming systems. Moreover, unlike that of the indigenous soil conservation measures, they are constructed in one go. This condition creates pressure on the households' labour. Of course, they are not only labour intensive to construct but also require tools, often unavailable to many households, and can, if not correctly constructed and/or adequately maintained, result in worse erosion than having no conservation measures. Furthermore, the 'conventional' soil fertility enhancing measures, that is artificial fertilizers, are characterized by high financial requirement, which can not be easily afforded by the subsistence farmers' of the study watershed.

As noted in the foregoing discussion, both the indigenous practices and the 'conventional' measures have limitations, and none of them alone can effectively overcome the problem of land degradation in the study watershed. But they also have features that can be linked and developed into a more sustainable land management practices. The indigenous conservation practices can be improved and linked with the 'conventional' measures on slopes not only to control erosion but also to minimize seed and fertilizer loss. For instance, the traditional ditches can be complimented with the fanya juu bunds in order to minimize the loss of soils by water erosion. The former is considered tobe space saving while the latter one is space taking measure. The farmers would benefit much more than they would from either of them alone if they were to integrate the strong features of both.

Thus there is an urgent need for linking the indigenous practices with the 'conventional' land management measures to develop more effective and sustainable land management systems. Practices such as manuring, mixed cropping, crop rotation, and crop rotation should be refined and linked or integrated with such 'conventional' practices as using artificial fertilizers. To be more effective and sustainable in the highlands of Ethiopia in general, and the study watershed in particular, land management packages should be low cost and adaptable to the local biophysical conditions.

# CHAPTER-VI
# CONCLUSION AND RECOMMENDATIONS

## 6.1 CONCLUSION

Agriculture is the most important economic activity in the northwestern highlands in general and the study watershed in particular. The watershed is typical of the high-potential, intensively cultivated, mixed farming, ox-plough cereal belt in the northwestern Ethiopian highlands. The overall farming system is strongly oriented towards grain production and is dependent on the use of oxen for land preparation and traditional grazing on communal lands. However, the performance of the agricultural sector is highly affected by land degradation in the form of soil erosion and soil fertility decline. The human-induced soil erosion [either by water or by tillage operations] and soil fertility deterioration are serious problems as well as threats to agricultural productivity in the northwestern highlands where the study watershed is located.

The factors contributing to soil degradation are varied, complex and interrelated. They can be biophysical, socio-economic and demographic. Of the natural factors causing land degradation, high intensity of rainfall and slope gradient are found to be the major ones. From the socio-economic and demographic factors the farming system and population pressure are the most important ones. The socio-economic and demographic factors affect land degradation through their impacts on farmers' decision with respect to land use and land management practices. Moreover, faulty/defective conservation structures are also found to be potential causes of the soil erosion problem in the study watershed.

Farmers' of the study watershed do have good perception of the problem of land degradation. The soil erosion problem is perceived by the majority of the sampled households in terms of reduced productivity of land, gully encroachment on arable land; decrease in the capacity of soils to grow a variety of crops they formerly grow, decrease in top soil depth; decline in the water holding capacity of soils; and decline in yield from the farm. Farmers also do have good knowledge of soils. And they also see soil fertility as a multi-faceted concept, such as soil's capacity for long-term productivity, its permeability, water holding capacity, drainage, tillage and manure requirement, and how easy it is to work. Various easily observable indicators are used by the farmers' to assess whether soil fertility is declining or not. The principal indicator mentioned is reduced crop yield. In addition, they mentioned the appearance of some weed species like *Mech* (*Gizatia scabre*), *Adyo* (*Carcopsis spp*.), *Asendabo* (*Setaria verticulate*), *Sinar* (*Avena abyssinica*), *Engcha* (*Strychmos innocua*), *Gortebe* (*Plantage spp*.), *Lute or Strungig* (*Rumex strou delili*), etc., as indicators of soil fertility decline.

Pool of land management practices were/are practiced by farmers of the study watershed. These measures are well adapted to local conditions and widely practiced by farmers. In the study conducted, two types of indigenous land management practices have been observed. These are household-level and supra-household level (neighborhood level and community-level) land management practices.

The indigenous physical soil conservation techniques that are applied to control erosion include construction of stone bunds, traditional ditches ('feses'), traditional waterways ('Behalwi boyi'), traditional cutoff drain ('tekebekeb'*), and contour ploughing*. In addition, different indigenous agronomic conservation practices are also employed for land management sake. These include *inter-cropping and cover-cropping, improved or seasonal fallowing through cropping 'gibto'(Lupines lupine), manuring through animal parking weed heaping,* *and crop rotation.* These indigenous agronomic measures are also found to be important measures of enhancing the fertility of soils.

Though farmers apply different land management practices since long-time, the problem of land degradation has not been solved or minimized. Rather, it continuous unabated. Understanding this problem, different 'conventional' land management measures have been introduced, mainly by the government. The conservation measures that are newly introduced are the *fanya juu bunds, check dams or 'kiter' and artificial waterways* from soil conservation measures and artificial fertilizers [DAP and Urea] from soil fertility enhancing measures. However, the introduced 'conventional' measures seem to be not accepted and extensively applied by farmers' of the study watershed. Instead, farmers' continue practicing their own indigenous land management measures though the problem of land degradation is unabated and agricultural productivity is not enhanced.

Several factors affect farmers' decision to invest on land management activities as well as their decision on the choice of land management measures. Land holding size, land fragmentation and land ownership are found to be important land related factors. Livestock size, labour availability, and production asset ownership are the other factors that affect farmers' decision [positively or negatively] to invest on land management activities and/or their choice of land management measures.

Most indigenous land management practices are characterized by several strengths, such as multi-functionality, multiple benefits, flexibility, low external input dependence, and efficiency in labour utilization, complimentarity, and compatibility to the prevailing farming system. On the other hand, some of them are characterized by some limitations. Some are labour intensive whereas others may, if they are ill designed, aggravate soil erosion. On the other hand, the 'conventional' are reported to be less flexible, space taking, incompatible to the farming system, labour intensive, high external input dependent, etc. Therefore, due to all these multifaceted limitations of the 'conventional' measures, farmers of the study watershed are found to be reluctant to accept and implement the measures.

## 6.2 RECOMMENDATIONS

In order to achieve sustainable land management in the foreseeable future in the study watershed in particular and the northwestern highlands at large, the following points should be critically considered,

Farmers' of the study watershed do have valuable knowledge of the biophysical setting of their locality [their land], and have developed their own indigenous land management practices that are suitable to the biophysical settings and fit the socioeconomic conditions. Therefore, this valuable knowledge of farmers' and their locally adapted indigenous land management practices should be seriously taken into account as they are helpful to understand the local biophysical conditions and provide the starting points for development of alternative sound and sustainable land management systems.

Moreover, understanding the indigenous land management system may reveal important clues for the development of alternative sound and sustainable land management solutions and may encourage farmers' to actively participate in land management activities. Therefore, there is need to critically assess their merit and demerits of the measures, take a lesson from their merits, and hence link them to the 'conventional' measures to achieve the desired goal.

3. The newly introduced 'conventional' land management [both soil conservation and soil fertility management] measures are not designed based on the microscale biophysical and

soioeconomic realties. Therefore, before introducing new measures and implement them, the realities at the ground should be critically assessed by participating farmers. This may enable to develop appropriate technology that best fits the current land use system as well as to the microscale biophysical conditions and socioeconomic realities.

4. In addition, farmers are found to be more willing to accept and implement land management measures

(i) that can be easily integrated in to the prevailing farming systems. Therefore, land management measures should be designed to suit and fit the prevailing farming systems

(ii) which do not require too much labour input. Therefore, land management measures that are designed and introduced should be not labour intensive.

(iii) that are not space taking. Therefore, space saving land management measures should be designed.

(iv) that can be implemented by locally available materials. Therefore, low external input dependent land management measures should be designed and introduced.

(v) that are multi-functional and have multiple benefits. Therefore, land management practices that are designed and introduced should be multi-functional and with multiple benefits.

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**Appendix 1**

A formal household survey questionnaire for a study on land management practices in *Digil* Watershed.

**ADDIS ABABA UNIVERSITY**
**SCHOOL OF GRADUATE STUDIES**
**COLEEGE OF SOCIAL SCIENCES, DEPARTEMENT OF GEOGRAPHY**

**Part I: Socioeconomic and demographic characteristics of the sample households of the study area**

**A.Household characteristics**

1. Personal Information

Household (HH) head

Name --------------------------- Sex ---------------------------

Age --------------------------- Religion ---------------------------

Place of Birth: Region ___________ Zone____ Woreda____ Kebele_____

Duration of stay at current place_____(years)

Number of household members____________ Male_______ Female_______

2. Do you want to have more children?

Yes 1 No 2

3.If yes, how many? _____________________________

Why? _____________________________

4. If no, why? _____________________________

5. Do you think that your family labor sufficient to manage your land?

Yes 1 No 2

6. If no, where and how do you get extra labor force to manage your land?______

**B. Crop production**

7. Do you have the following production assets?

| Type | Yes 1<br>No 2 | Number |
|---|---|---|
| Iron plough(Maresha) | | |
| Yoke(Kenber) | | |
| Plow beam(Mofer) | | |
| Shovel/Spade(akafa) | | |
| Sickel(machid) | | |
| Saw(megaz) | | |
| Iron hoe(doma) | | |
| Axe(metrebia) | | |
| Kerosene Stove(butagas) | | |
| Fanos/masho | | |
| Radio | | |
| Jerican | | |

8. Are these production assets sufficient to manage your land?

Yes 1 No 2

9. If no, where and how do you get these production materials?________

10. How do you cultivate your land?

Using own pair of oxen 1
Using shared oxen 2
Using hired oxen 3
Using family labor alone 4
Using hired labor 5
Exchanging labor for pair of oxen 6
Sharecropping of the land 7
Other, specify---------------------------------- 8

11. Does your cultivation system have any positive/negative effect on your land management practice?

Positive 1 Negative 2 I do not know 3

12. If positive, would you please list down some of the effects?______________

13. If negative, would you please list down some of the effects?______________

14. Which crop types you commonly grow during the Belg and Kiremet seasons

| Crop type | Season( Belg or Kiremt) | Area cultivated in ha. | Yield(Kg/ha) and Price( Birr/Quintal) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1991E.C | Price/qt | 1992 E.C | Price/qt | 1993 E.C | Price /qt |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

15. Is your produce (yield) increasing or decreasing, in general, over the past five years?

Increasing 1 Decreasing 2 The same 3

16. If increasing, do you think that it is the result of your land management effort?

Yes 1 No 2 I do not know

17.If decreasing, what do you think the reasons be?________________

**C. Livestock ownership**

18. Do you have livestock?

1 Yes 2 No

19. If yes, indicate type and number of the livestock.

<u>Type</u> <u>No</u>
Ox _______
Cow _______
Heifer _______
Calf _______
Goat _______
Sheep _______
Others _______

20. What problems do you face in raising your livestock?

Lack of grazing land 1
Lack of water 2
Diseases 3
Wild animals 4
Other, specify_________________ 5

21. Where do you graze your livestock?

| | |
|---|---|
| Private grazing land | 1 |
| Private fallow land | 2 |
| Communal grazing land | 3 |
| On crop residues | 4 |
| Stall feeding | 5 |
| Other, specify | 6 |

22. Dose grazing land increase or decrease in your area?

Increases 1 Decreases 2 No change 3

23. If decreases, what do you think be the reasons are? __________

24.In your opinion, dose the type and number of your livestock have positive or negative effect in your land management effort/activity?

Positive 1 Negative 2 I do not know 3

25. If positive, would you please list some of the effects?________

26. If negative, would you list down some of the effects?_______

**D. Land holding and land fragmentation**

1.What is the size of your land holding?

Home compound ……..ha
Cultivated land ……. ha.
Grazing land………….ha.
Other, specify--------
Total_____________ ha.

2. How did you obtain yours plot of land?

| | |
|---|---|
| Inherited | 1 |
| Through land redistribution(1970s;1997) | 2 |
| Through rent/lease | 3 |
| Through purchase | 4 |
| Some inherited some obtained through land redistribution | 5 |
| Some inherited some rented | 6 |
| Other, specify….. | 7 |

3.In your opinion, do you think that your land ownership style affects your land management effort? Yes 1 No 2

4.If yes, how? (Please give your reasons)

5.If no, why not?________

6. How is the location of your plots?

| | |
|---|---|
| Hillside | 1 |
| Plain area | 2 |
| Valley bottom | 3 |
| Other, specify | 4 |

7.In your opinion, dose your plot location affect your land management effort?
Yes 1 No 2

8. If yes, how?_______

9. If no, why not?

10. If you own more than one plot,

How far is the farthest plot from your home?
In minutes------------------------------------------
In meters or kilometers---------------------------
What is the distance between two farthest plots?
In minutes -----------------------------------------
In meters or kilometers---------------------------

12. Does the fragmentation of your plots have any adverse effect on your land management effort? Yes 1 No 2

13. If yes, what are these effects?___________

14. Is the land that you possess now adequate to sustain your family?
Yes 1 No 2
15. If no, what size of land would be enough to your family?……(ha)
16. In your opinion, is the land getting a scarce resource?
Yes 1 No 2
17. If yes, why is that so?
18. What are some of the adverse effects of shortage of land on your land management activities?______________________________
19. Had the 1970s and1997 land redistributions any positive or negative effect on your land management activities/efforts?
Positive 1 Negative 2 I do not know 3
20. If positive, would you list down some of the effects?_____________
21. If negative, would you list down some of the effects?____________
22. Do you fear that you may lose of your land holding due to redistribution in the future? 1. Yes 2. No
23. If yes, dose it affect your land management activities?
1. Yes 2. No
24. If yes, how? _____________________
25. If no, why not?___________________

**Part II : Land management practices**

**A. Farmers' knowledge of soils**

1. How many types of soils do you know?________
2.What is their name?

| Type of soil (local name) | Color | Consistence | Depth | Slope position | Fertility condition | Stoniness |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | Black | Very sticky | Deep | Hillside | Very fertile | Very stony |
| | Red | Moderate | Average | Valley bottom | Moderate | Moderate |
| | Yellowish | Less sticky | Sallow | Plain | Less fertile | Not stony |

3.From which types of soil/s do you get good /better yield?

| Soil type (local name) | Type of crop/s | Estimated yield(kg/ha) | Reasons |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

4.Do you think that these better yields are the result of your land management activities?
Yes 1 No 2
5. If no, so what? ____________________________

**(a). Soil erosion Control**

1. Is soil erosion a problem on your plot of land?

    1. Yes  2. No

2. If yes, how do you perceive the presence of soil erosion?

| | |
|---|---|
| Gullies appear | 1 |
| Soil productivity decreases | 2 |
| Decrease in capacity of soils to grow a variety of crops it formerly grows | 3 |
| Decrease in the depth of top-soil | 4 |
| Decline in the water holding capacity of soils | 5 |
| Decline in yield from the farm | 6 |
| Other, specify | 7 |

3. Do you think that the rate of erosion is increasing or decreasing in your locality?

| | |
|---|---|
| Increasing | 1 |
| Decreasing | 2 |
| Same | 3 |

4. If so, how do you rate the magnitude of the problem?

| | |
|---|---|
| Very severe | 1 |
| Severe | 2 |
| Moderate | 3 |
| Low | 4 |
| Very low | 5 |

5. What do you think be the main reasons for the problem of soil erosion on your plots?_______
(Land being on steep slope, too much rainfall, and soil too erodible type, run off from up slope, upland degradation, etc)

6. Which type of soil erosion is occurring on your field?

| | |
|---|---|
| Sheet erosion | 1 |
| Rill erosion | 2 |
| Gully erosion | 3 |
| Other, specify------------------------- | 4 |

7. Do you believe that it is possible to control soil erosion?

    Yes 1  No 2

8. If yes, how?_________

9.If no, why?___________

10. Did you use traditional soil conservation measures to minimize the rate of soil erosion on your plots in the last harvesting season?

    Yes 1  No 2

11. If yes, give us some details

| Type of indigenous soil conservation measure used* | Number of plots treated | Area in ha. | Problem encountered |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Stone bund(kab) , Traditional ditches(fesses), Unploughed strip(Dinber), Traditional cut-off drain(tekebekeb, Trass boy), Traditional water ways(Boy), etc.

12. Which traditional soil conservation measure (s) do you think is more efficient?__________

13. What do you think be their main strengths are?______
14. Is your farm plot currently treated with 'conventional' soil conservation measures?
Yes 1 No 2
15. If yes, starting from when?
1-3 years 1 4-6 years 2 7 and above years 3
16. What sort of 'conventional' soil conservation measures do you apply?_______
17. Which 'conventional' soil conservation measures do you think are effective?__________
18. Can you point out the major weaknesses of 'conventional' measures?_________
19. If you are applying any 'conventional' conservation measure, where did you learn about it? ______
20. Have you been given a chance to participate and take decision concerning 'conventional' soil conservation measures?
Yes 1 No 2
21. If yes, on which of the following activities?

| | |
|---|---|
| Identification of conservation technologies | 1 |
| Selection of conservation technologies | 2 |
| Prioritizing of conservation technologies | 3 |
| Implementation of conservation | 4 |
| Others __________________________________ | 5 |

22. Do you think that indigenous soil conservation measures are inferior to the 'conventional' ones in tackling the problem?
Yes 1 No 2
23. If yes, in what respect?_________
24. Do you think that the indigenous soil conservation measures need upgrading/improvement?
Yes 1 No 2
25. If yes, how?____________
26. If no, why?_____________
27. Do you think that 'conventional' soil conservation measures similar or different from among the indigenous ones?
Similar 1 Different 2 I do not know 3
28.If your answer is similar, in what respect?__________
29. If different, in what respect?____________
30. Do you think that integrating the two measures will give a lasting solution for the problem?
Yes 1 No 2

31. If yes, which measures should be integrated? ________
32. Have you ever attempted to integrate them so far?
Yes 1 No 2
33.If yes, how?____________
34. If no, why?______________
35. In your opinion, which 'conventional' soil conservation measure/s have you implemented well.

| Conservation measure | Reason |
|---|---|
| _________________________ | _________________________ |

36. How do you rank 'conventional' technologies in relation to traditional ones?
Most important 1 Second important 2 Less important 3

**(b).Soil fertility management**

37. How do you observe the fertility level of your cultivated land?
Increasing 1 Decreasing 2 Remains same 3

38. If it is increasing, what are the reasons?

| | |
|---|---|
| Manuring | 1 |
| Fallowing | 2 |
| Dumping household excreta, ash, etc | 3 |
| Crop rotation | 4 |
| Using artificial fertilizer | 5 |
| Other, specify | 6 |

39.If it has been decreasing, what do you think the reasons are?

| | |
|---|---|
| Over cultivation | 1 |
| Unable to add manure | 2 |
| Unable to leave fallow | 3 |
| Vegetative cover destruction | 4 |
| Too much rainfall | 5 |
| Failure to apply conservation measures | 6 |
| Failure to use fertilizers | 7 |
| Other, specify | 8 |

40. Which soil type/s requires intensive soil fertility management?_________

41.Why? (Mention the reasons)___________

42.Which types of traditional soil fertility management measures are you practicing to improve the fertility status of the soils of your plot?

| | |
|---|---|
| Rotational cropping practices | 1 |
| Adding organic manure | 2 |
| Leaving the land fallow | 3 |
| Soil burning ( Gay) | 4 |
| Animal parking (temporary Kral or Chichit) | 5 |
| Cropping(Lupinus Lupini or Gibito) | 6 |
| Weed heap or trash line heap (Gulit/Dirit) | 7 |
| Other, specify | 8 |

43. What is your response to further declines in the fertility of cultivated land?

| | |
|---|---|
| Put under fallow | 1 |
| Practicing rotational cropping | 2 |
| Adding organic manure | 3 |
| Animal parking | 4 |
| Adding artificial fertilizers | 5 |
| Multiple cropping | 6 |
| Others, specify | 7 |

44. Why do you prefer the above fertility management practices?

| | |
|---|---|
| Less costly/affordable | 1 |
| Demand less labor | 2 |
| Easy to apply | 3 |
| Do not compete with other application | 4 |
| Can not afford chemical fertilizers | 5 |
| Due to insufficient supply of chemical fertilizers | 6 |
| Not aware of other alternative fertility management practices | 7 |
| Efficient than the 'conventional' ones | 8 |
| Because they are widely practiced by our community | 9 |
| Other, specify____________________ | 10 |

45. From the indigenous soil fertility management practices which ones do you think are inefficient?_

46.What are their major weaknesses?

47.Which indigenous soil fertility management practices are not currently practiced?_________

48. Why these measures have been abandoned from the system?

| | |
|---|---|
| Due to shortage of arable land | 1 |
| Due to growth of population | 2 |
| Due to their inefficiency | 3 |
| Because they are not included in the modern land management package | 4 |
| Other, specify _________________ | 5 |

49. Do you use artificial fertilizer on your fields?

1. Yes 2. No

50 . If yes, indicate the type and amount you use.

Type of fertilizer---------------------------

Amount per ha.-------------------------

51. How did you obtain artificial fertilizer?

| | |
|---|---|
| On credit/loan | 1 |
| On cash | 2 |
| Other, specify------------- | 3 |

52. Do you think that use of artificial fertilizer alone is a lasting solution for soil fertility decline?

1. Yes 2. No

53. If yes, why? __________________________

54. If no, what do you think be the lasting solution?_________

55. Have you ever attempted to use both [indigenous and conventional] soil fertility management practices in combination?

Yes 1 No 2

56. If yes, how?___________________________

57. What meaningful results have you got by doing so?_______

58. If no to Q55, why not?(mention your reasons)__________

Appendix 2

Treatment-Oriented Land Capability Classification scheme

| Slope / Soil Depth | Gently Sloping (<12%) (< $7^0$) | Moderately sloping (12-27%) ($7-15^0$) | Strongly sloping (27-36%) ($15-20^0$) | V. strongly sloping (36-47%) ($20-25^0$) | Steep (47-58%) ($25-30^0$) | Very steep (>58%) (>$30^0$) |
|---|---|---|---|---|---|---|
| Deep (>90cm) | C1 | C2 | C3 | C4 | FT | F |
| Mod. Deep (50-90cm) | C1 | C2 | C3 | C4/P | FT/F | F |
| Shallow (20-50cm | C1 | C2/P | C3/P | P | F | F |
| V. shallow (<20cm) | C1/P | P | P | P | F | F |

Sourec: Belay Tegene, 2002

*Appendix 3*

Characteristics and treatments for the capability units of the Treatment Oriented Capability Classification Scheme

| Group | Class | Characteristics and Recommended Treatments |
|---|---|---|
| Suitable for tiallge | C1 | Cultivable land; up to7$^0$ (< 12%) slopes; soil depth normally over 10cm ; require no or few intensive conservation measures, e.g., contour cultivation and strip cropping, vegetative and rock barriers and broad base terrace |
| | C2 | Cultivable land; slopes 7-15$^0$ (12-27%) with moderately deep soils; needs more intensive conservation, e.g., bench terracing; hexagons, mini-convertible terracing; conservation measures can be constructed by small sized bull dozers |
| | C3 | Cultivable land; slopes 15-20$^0$ (27-36%); bench terracing; hexagons, mini-convertible terracing, individual basins on less deep soils; conservation measures are constructed by small bull dozers |
| | C4 | Cultivable land ;slopes 20-25$^0$ (36-47%); bench terracing, hexagons, mini-convertible terracing, all conservation treatments are done by manual labor |
| | P | Pasture; Slopes approaching 25$^0$ (47%); soil depth too shallow for cultivation; use for improved or managed pasture and rotational grazing; zero grazing where land is very steep and too wet |
| | FT | Food trees/ fruit trees on slopes of 25-30$^0$ (47-58%); soil depth over 50 cm; use for tree crops with orchard terracing; inter-terraced; areas in permanent grasses; contour planting; diversion ditches; mulching |
| | F | Forest land; slopes over30$^0$ (> 58%) or over 25$^0$ (>47%); where soil is too shallow for any of the conservation treatments. |
| Wetland, liable to flood; also stony land | P | Wetland; slopes below 25$^0$(<47%); use as pasture |
| | F | Very stony land; slopes grater than 25$^0$(<47%); maintain as forest |
| Gully land | F | Maintain as forest land |

Source: Sheng (1977); cited in Belay Tegene, 2000a

Declaration

The thesis is my original work, has not been presented for a degree in any other University and that all sources of

Name___________________________

Signature ____________________

Addis Ababa University

June, 2002