ADDIS ABABA UNIVERSITY

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COLLEGE OF SOCIAL SCIENCES AND HUMANITIES

BENEFITS AND CHALLENGES OF ADOPTING SOIL CONSERVATION TECHNIQUES IN GOROMTI WATERSHED, CENTRAL ETHIOPIA

BY: ADDISU DAMTEW

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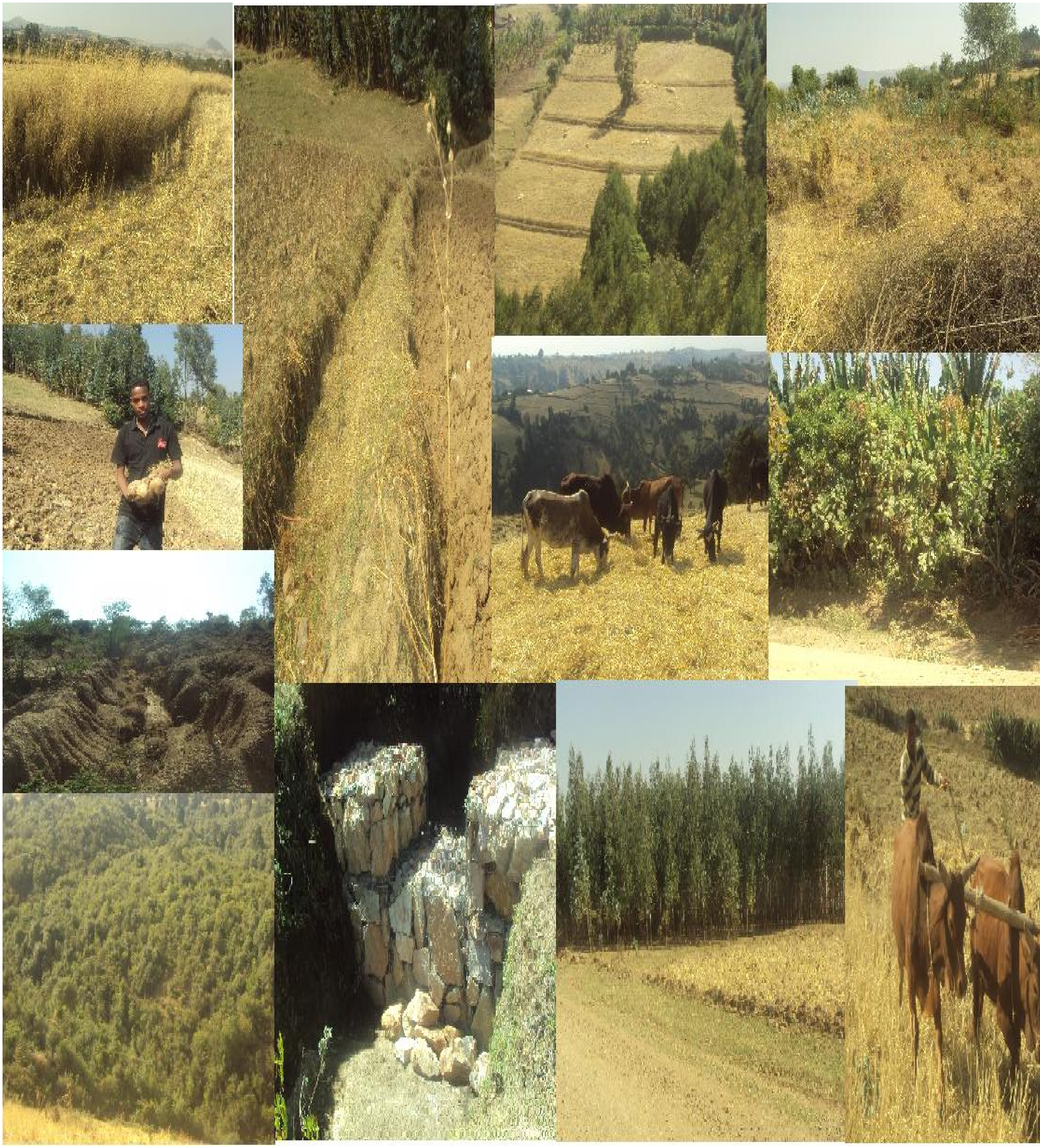

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Dedication to my beloved father Ato Damtew Atnafe and Ato Kiflom Zeleke, whom I lost them for ever, let my god rest their soul in peace!

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Above all I thank the LORD GOD for giving me the strength to start and go through with my studies.

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LIST OF ACRONYMS

ADLI	Agriculture Development-Led Industrialization
AWARDO	Ambo Woreda Agriculture and Rural Development Office
CFW	Cash for Work
CSA	Central Statistics Authority
DA	Development Agents
FAO	Food and Agricultural Organization
FC	Financial Cooperation
FFW	Food for Work
GDC	German Development Cooperation.
GDP	Gross Domestic Product
GIS	Geographic Information System
GTZ	German Agency for Technical Assistance
Ha	Hectares
HHs	Households
MARD	Ministry of Agriculture and Rural Development
MOA	Ministry of Agriculture
NARM	Natural Resource Management
NGOs	Non Governmental Organizations
SIDA	Swedish International Development Agency
SPSS	Statistical Package for Social Science
SUN	Sustainable Utilization of Natural Resources for Improved Food Security
SWC	Soil and Water Conservation
TC	Technical Cooperation
USAID	United States Agency for International Development
USD	United States Dollar
WB	World Bank
WFP	World Food Programme
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PSNP	Productive Safety Net Program

ABSTRACT

Land degradation is one of the major challenges in agricultural production in many parts of the world, especially in developing nations, such as Ethiopia. A number of soil and water conservation methods were introduced to combat land degradation but adoption of these practices remains below expectations. The main objective of the study is to assess the benefits and challenges of adopting soil conservation techniques in Goromti watershed. For this purpose household questionnaire, key informant interview and observation were used to generate both qualitative and quantitative data. Field survey was conducted to collect the necessary data from 107 sample households, which were selected via simple random sampling Illamu Goromti, Ya'i Chebo and Boji Bilo associations. The household survey questionnaire data have been tabulated and summarized by utilizing the statistical package for social science (SPSS).

The study revealed that factors such as slope of the area, contact with extension workers, tenure status, age, size of house hold and training influenced farmers to adopt soil and water conservation methods. Soil bund, fanya juu, water way, cut off drain and grass strips are the major soil conservation methods adopted in the area. Opportunities related to adopted methods of soil conservation are effective in addressing on farm flooding and soil erosion. They also increased productivity, vegetation cover and soil moisture content.

Despite the benefits the study also revealed that some farmers failed to maintain adopted methods of soil conservation. This was mainly due to the conservation methods took and reduced plot size, poor design; need more labor and lack of incentives. These short coming of the conservation structures are the major causes for lack of maintenance of structures, development and efficient control of erosion.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Land degradation in the form of soil erosion, deforestation, overgrazing, salinization and alkalization contributes significantly to low agricultural productivity. This causes food insecurity and poverty in many developing countries of the world including Ethiopia (Pagiola 1999; Shiferaw *et al*., 2007). In Ethiopia agriculture forms the dominant sector of the economy which provides about 52 % of the country's gross domestic product (GDP), over 80 % of its employment, and 90 % of its export earnings (World Bank, 2000).The rates of soil erosion in Ethiopia are frighteningly high. Serious erosion is estimated to have affected 25 % of the highland area. Close to four % of the highlands are now so seriously eroded that they will not be economically productive again in the foreseeable future (Teklu and Gezahegn, 2003).

Soil erosion in Ethiopia can be seen as a direct result of past agricultural and other related practices in the highlands. The dissected terrain with steeper slope gradients and the high intensity of rainfall lead to accelerated soil erosion once deforestation occurs (Badege, 2001). The causes of land degradation include such factors as population pressure on resources; poverty; high costs or limited access of farmers to fertilizers, fuel and animal feed; insecure land tenure; limited farmer knowledge of improved integrated soil and water management measures; and limited or lack of access to credit (Gebremedhin, 2004). The existence of high concentration of both human and livestock population in the highlands of Ethiopia, the continued intensive cultivation exacerbated by inappropriate land use practices, a stagnant productive technology and other factors have culminated in ecological disaster (Alemu, 1999; FAO, 1985).

In order to protect soil resources from erosion, considerable efforts should be made to ensure the life continuity in the future. Achieving sustainable pathways out of the downward spiral of land degradation and poverty requires that farmers adopt profitable and sustainable land management practices, or pursue alternative livelihood strategies that are less demanding of the land resource (Mahmud and Pender, 2005).

To reverse the major problems of soil erosion, massive soil conservation and afforestation programs have been ongoing in Ethiopia since the early 1970s (Hurni, 1990; Gemachu, 1988). Considerable public resources have been mobilized to develop soil and water conservation (SWC) technologies and promote them to be used by farmers. Examples of technologies advanced throughout the country include structural methods, such as soil and stone bunds; agronomic practices, such as grass strips and agro-forestry techniques; and water harvesting options, such as tied ridges and pond construction (Shiferaw *et al*., 2007). Soil conservation in Ethiopia is considered to be of top priority not only to maintain and improve agricultural production but also to achieve food self-sufficiency (Grunder, 1988). The United Nations Development Program and the Food and Agricultural Organization (FAO) have been helping Ethiopia to promote tree planting and soil conservation programs in the highlands mainly to reduce degradation of soil resources and improve productivity of agricultural land (FAO, 1986).

Goromti watershed is found in Ambo Woreda (District). The topography of the area is very steep and rugged and much parts of the watersheds slope gradient fall above 15% (AWARDO, 2006). Farmers are expanding their cultivation land into forest and steeper lands, which accelerates soil erosion. In the watersheds, the stock of natural resource is degrading as expressed by gully formations.

The local Government in collaboration with Non Governmental Organizations (NGOs) is trying to conserve these watersheds through developing the existing indigenous knowledge as well as expanding methods of soil and water conservation techniques having the aim of not only conserving and protecting the land and water but also achieving food security in the area. In the study area, GTZ and Government of Ethiopia have been supporting agricultural development and natural resource management of the watersheds. To reverse the problem of soil erosion, it is important to understand the actual impact of adopted methods of soil conservation on resource-poor farmers and identify constraints that inhibit adoption of these measures. Thus, this present work is designed to assess the benefit and challenges of adopting method of soil conservation in the Goromti watershed.

1.2. Statement of the Problem

Land degradation in the form of soil erosion has been a problem ever since man started to cultivate the soil and grazed domesticated animals. Land degradation was a significant global issue during the 20th century and remains of high importance in the 21st century as it affects the environment, agronomic productivity, food security and quality of life (Eswaran *et al*. 2001). A survey of soil degradation by the International Soil Reference and Information Center estimated that nine million Hectares of land around the world are tremendously degraded; with their original biotic functions completely disappeared, and 1.2 billion Hectares, i.e. 10 % of the earth's vegetative surface, are at least moderately degraded (WRI *et. al*, 1996). The combination of the rapid growing world's population, slow economic growth and limited natural resources, especially in many developing nations, is creating serious long-term sustainability problems for the world's natural resources (FAO, 2008). For developing nations, soil erosion is among the most chronic environmental and economic burden (Taffa, 2002).

With high-intensity rainstorms and extensive steep slopes, steep lands in particular suffer from high rates of soil erosion and nutrient loss. Although data on the extent of the problem are patchy and inconsistent, available estimates indicate that soil erosion averages nearly 10 times the rate of soil regeneration in the highlands, and the rate of soil nutrient depletion is the highest in sub-Saharan Africa (FAO, 1993; Hurni, 1988, 1993; Stoorvogel *et al*., 1993).

Ethiopia has among the highest estimated rates of soil nutrient depletion in sub-Saharan Africa which reduces productivity and increases vulnerability to drought and food insecurity (Stoorvogel and Smaling, 1990). In Ethiopia, agricultural land productivity is being seriously eroded by unsustainable land management practices both in areas of food crops production and grazing lands (Berry, 2003).

There are many factors responsible for land degradation in Ethiopia. According to Fassil (1993), the problems of degradation of land resources may be attributed partly to the failure to take due care of resources while remaining unaware of the tragic consequences. Lack of adequate nutrient supply, the depletion of soil organic matter, and soil erosion are major obstacles to sustained agricultural production (Grepperud 1996; Kassie *et al*. 2008). But there were and still are more fundamental natural and socioeconomic factors responsible for the degradation of land resources including soil. The loss of soil and the deterioration in fertility, moisture storage capacity reduce the country's agricultural productivity. The problem is serious particularly in the highlands (>1500 meter above sea level) that comprise nearly 44% of the country's total area, 95% of the cultivated area, about 88% of the human population, and two-thirds of the country's livestock (Kruger *et al*., 1996).

Soil erosion is severe on cultivated lands, where the average annual loss is 42 tons/ha, compared with five tons/ha from pastures (Hurni, 1993).The highest average rates of soil loss are from formerly cultivated lands that are currently unproductive because of little protective vegetative cover.

The capacity of the highland farming communities to sustain production is, therefore, under serious pressure (Hans-Joachim *et al*., 1996). Bojo and Cassells (1995) thoroughly assessed land degradation in the Ethiopian highlands and indicated that the immediate gross financial losses due to land degradation were about USD 102 million per annum which constituted about 3 per cent of the country's GDP at the time.

Over the years, farmers devised indigenous practices and systems of land use to protect and rehabilitate their lands but most have been abandoned as population growth has placed greater pressure on the land. The key to a prolonged increase in agricultural production is to improve land productivity, which can be achieved through better technology and efficiency.

As part of the solution to land degradation, in the Goromti watershed both the government and NGOs are participating in rehabilitating the degrading areas via community watershed management. Among others, the activities include gully treatment, degraded hill treatment, soil and water conservation through physical and biological techniques treatments. Farmers in these watersheds get some benefit as a result of the participatory community watershed management as well as face several constraints. Hence, the present work tried to assess the opportunities and challenges of implemented soil conservation techniques in the Goromti watershed.

1.3. Objectives of the Study

The general objective of the study was to assess the benefits and challenges of adopting methods of soil conservation in Goromti watershed.

Specifically the study had the following objectives

A) To identify adopted methods of soil conservation in the study area.

B) To investigate the benefits that farmers obtain from adopted soil conservation techniques.

C) To study challenges farmers face in adopting soil conservation techniques on their farm plots.

D) To recommend on approaches to minimize challenges farmers face in adopting soil conservation techniques.

1.4. Research Questions

The study tried to answer the following research questions

A) What are the adopted methods of soil conservation techniques?

B) What are the benefits that farmers get as a result of adopted soil conservation techniques?

C) Do farmers face challenges in adopting soil conservation techniques?

D) What measures should be taken to improve challenges meet farmers in adopting soil conservation techniques?

1.5. Significance of the Study

Sustainable natural resources management becomes the main concern of the Ethiopian rural development strategy starting from the last couples of decades. This is because the growth in the number of mouths to be fed and proportionally low production and productivity led to alarming rates of land degradation and environmental imbalances due to poor management of natural resources. Understanding the benefits and challenges farmers meet in adopting soil conservation techniques is helpful to farmers to fully adopt or discontinue the use of adopted method of soil conservation. Thus, the proposed research will have a contribution to pick out the benefits and constraints farmers experience in the process of adopting methods of soil conservation techniques in the study area. Thus, the result of the study has the following significance.

- ➢ It will be helpful in identifying opportunities and challenges of adopting soil conservation techniques in the study area.

- It can provide information to soil conservationist and agricultural extensionists regarding opportunities and challenges of adopting the soil conservation techniques in the study area.
- The study result may serve to provide information for other researchers who desire to make future studies on similar aspects of study.

1.6. Delimitation and Limitation of the Study

There are so many areas to be researched in the Ambo Woreda. Out of these, challenges and opportunities regarding adopting soil conservation techniques is important because since adopted method of soil conservation in the area is considered as the stepping stone in expanding conservation structures to other areas that have more or less the similar physical setting and in this aspect study has not been adequately researched. For this reason, it is not possible to deal with other problems and other parts of the West Shewa zone. Hence, the study is limited to focus on opportunities and challenges of adopted soil conservation methods on farm plot in Goromti Watershed of Ambo Woreda, West Shewa zone, Oromia Regional State.

Although the study related to benefits gained and challenges meet due to conservation activities need was serious, the quality of the information gathered through structured survey questionnaire depends on the willingness, recalling capacity and knowledge of the respondents. In addition to these laboratory tests were needed in which the researcher faced lack of finance to do so. These were some of the limitations of the study the results can be used to. Irrespective of this, the researcher exerted continuous effort to make the research reliable and valid.

1.7. Research Methodology

1.7.1. Sampling Size and Techniques

In order to get representative and reliable information and to draw important conclusion about the study area, employing sound methodologies principle is pre- requisite. Thus, the researcher used both probability and non probability (purposive) sampling methods as techniques of sampling. Simple random sampling from probability sampling is used to select farmers from the Goromti watershed who adopt the method of soil conservation. Towards this end, two stage sampling procedure was used.

In the first stage, out of watersheds in the Ambo Woreda, Goromti watershed is purposively selected based on the conservation measures applied in the last decade; in which the researcher believed that farmers in the watershed adopt different methods of soil conservation.

In the second stage, the purposive selection of all development team (Within the watershed farmers have their own '*garee misoomaa*' (development team) which are responsible to manage their land) was made as farmers in different development team may be benefited from various conservation activities depending up on their local environmental set up. The target population of the study is 534 households (HHs) who inhabit Goromti watershed and adopted the soil conservation methods in and out of their farm plot. Development Agents (DA), government authorities and other concerned bodies were included as informants.

Because of too many household in the study area, it is difficult to administer questionnaire and conduct interview to all of them. Thus, the researcher used 107 HHs (20%) farmers (Table 1) and Development Agents who assist farmers in the watershed. Government authorities, Non Government Authorities and 5 development team leaders (who know and practice the adopted method of soil conservation) who have been working in the area also had been used as a sampling population. In the study area the watershed has three kebeles namely: Illamu Goromti, Ya'i Chebo and Boji Bilo. Hence, farmers were selected proportionately by the Kebele population size who adopted soil conservation techniques within the watershed.

To get each individual farmer household, researcher used simple random sampling by lottery method from their name list available in their respective Kebele as follows (Kothari, 2004).

nh = $(Nh/N) \times n$ where,

nh= sample size of the stratum

Nh= total household head in each stratum

N= total population (total head of the household in the study area)

n = total sample size of the study

Table1: Sampling Frame of Respondents

Name of Kebele in Watershed	Household Size	Sample Household Size	Percentage respondents
Ya'i Chebo	222	45	42
Illamu Goromti	286	57	53.3
Boji Bilo	26	5	4.7
Total	534	107	100

Source: Field survey, (2010)

1.8. Sources of Data

In order get reliable and valid data, the researcher used both primary and secondary data. The primary data were collected through questionnaire, key informant interview with NARM expert, selected farmers and observation check list (Appendixes D, E, F and G), development agents and authorities at various levels from government and non-governmental organization who have been working in the watershed on soil conservation. Secondary data were gathered from published as well as unpublished documents and reports available on the study area.

1.8.1. Data Collection Instruments

Questionnaire

Questionnaire is used as a data collection instrument, because of its advantages to involve large number of respondents' and ease of administration, and the results being readily analyzed. The researchers prepared both open ended and close ended questionnaires which are translated into study area language (*Afaan Oromo*) and developed on the basis of the objectives of the study. These questionnaires were administered by the researcher and trained enumerators (Appendix B).

Key informant Interview and Observation

Interview method is particularly suitable for intensive investigations and allows the researcher and respondents to ask and respond freely (Kothari, 2004).The researcher conducted interview with authorities, development team leaders who adopt the method of soil conservation and development agents. The researcher prepared both structured and semi-structured interview guides which were administered to authorities and development leaders. The researcher also prepared observation check list which is helpful in identifying the problem as well as cross checking each survey questionnaire administered to informants.

1.8.2. Method of Data Analysis

Data which were collected from both primary and secondary sources were analyzed, summarized and presented via quantitative and qualitative method of data analysis. Questionnaire which is gathered from respondents is quantitatively analyzed, summarized and presented in table, graph, ratio and percentage. In addition to these bivariate correlations between some variables were analyzed using (Statistical Package for Social Science) SPSS Version 17.0 and MS excel.

Data which were gathered through observation, interview and focus group discussion were qualitatively analyzed.

1.9. Organization of the Paper

The study is organized into five chapters. The present chapter (Chapter one) presents the introduction, which focuses mainly on the background, statements of the problem, objectives, significance and scope of the study, data source and its method of collection, sampling techniques and methods used. Chapter two provides review of related literature which describes some related concepts regarding the adoption of soil conservation. It further gives an over view of soil conservation in different point of view. Chapter three deals with a short description of the study area. Chapter four presents the results and discussion of the study. Finally, Chapter five deals with conclusions and recommendations drawn from the study to improve small holder farmers continue use of adopted method of soil conservation.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Concept and Definition of Soil Conservation

When man appeared on the scene and started abusing nature, the situation changed. He started to cut trees and grasses, and rip up the land for cultivation to meet his daily needs. This causes the removal of soil from where it is formed to some other parts where it could be deposited; the process can be described as soil erosion. Soil erosion is one facet of land degradation that affects the physical and chemical properties of soils. It is a process that removes soil layers and carries them away from farm fields to bodies of water or other land and that has been going on for as long as the world has existed (Sanders, 2004). Erosion results in the loss of valuable soil and its nutrients that are necessary for crops to grow.

Soil conservation can be defined as the protection of fertile topsoil from erosion by wind and water and the replacement of nutrients in the soil, as by means of cover crops, terracing, contour farming, crop rotation, etc. Soil conservation is not restricted to the protection of threatened hillsides or their rehabilitation by planting of trees. Its scope is much larger in that it involves the whole agricultural and natural resource conservation (MOA, 1989). It includes the combination of the appropriate land use and management practices that promotes the productive and sustainable use of soils and, in the process, minimizes soil erosion and other forms of land degradation (Sanders, 2004). It most often attempts to ensure that soil does not erode and washed away a blow away in the wind but it also involves the protection of the soil from damage by machinery (e.g., compaction) or by detrimental changes to its chemistry (e.g., acidification or Salinization). Generally Soil conservation includes all forms of human action to prevent and treat soil degradation (IIED, 1998).

The aim of soil conservation is to facilitate optimum level of production from a given area of land while keeping soil loss below a critical value (Yibabe and Mitiku, 2002). Protections of the life-supporting capacity of soils include soil quality factors such as soil depth, soil structure, water holding capacity, organic matter, soil fertility and soil fauna; soil processes; soil availability; soil versatility; and soil productivity.

2.2. Soil Conservation Efforts in Ethiopia

In Ethiopia the tradition of soil conservation has been common since historical times (Hans-Joachim *et al*., 1996). Yet due to inefficiency of traditional methods it was only after the famine of 1970s that many of the activities of soil conservation and resource degradation have been recognized to be a series problem in highlands of Ethiopia. Since the early 1970s subsequently disastrous drought and famine of the time, soil conservation measures were adopted in different parts of Ethiopia. Adopted conservation methods were diversion channel, terraces, stone bund and earth dam which are mainly practiced in highlands of Ethiopia. Initially, most of the soil conservation works included construction of the stones and earth embankments, which the farmers did not appreciate (Girma, 2001).

Largest conservation activities in the country are those implemented during the 1970s and 1980s for which farmers were mobilized at national level for campaign work (Woldeamlak and Sterk, 2003). Since 1990s resource conservation activities mainly soil and water conservation work in cultivated land have been undertaken as part of agricultural extension package of present government. However, the practice has remained delivery oriented in which the farmers are forced to implement conservation measures designed for them by technical experts.

The Ethiopian policy makers had largely ignored the problem of land degradation until the 1970s; apparently, the 1974 drought provided the initial motivation for the mobilization of rural labour force for conservation in the country using food for work (FFW) programmes (Gebremedhin, 2004). In addition to FFW and CFW (Cash For Work) programs, tree seedlings distribution at minimal prices for private use and free of charge for use in community lands has been another direct economic incentive used for soil conservation in the country (Gebremedhin, 2004). In fact, after nationalization much has been done to rehabilitate the eroded land. However, the nationalization of land agrarian reform in 1974 may have contributed to deforestation of protected mountain ranges and forestlands as people no longer had an incentive to preserve them. (Girma, 2001).

During the 1980s the then Government of Ethiopia launched a massive program of soil conservation and rehabilitation. The effort, which involved heavy external support culminated in the mobilization of peasant associations with over 30 million workdays per year (Hurni, 1986). It is after this period that national efforts for soil conservation expanded rapidly. Farmers in the northern, central, and southern part of Ethiopia construct stone terraces on their sloping lands to protect them from erosion and land sliding.

In most cases, the terraces are not protected with vegetative cover. Between 1976 and 1990, 71,000 ha of soil and stone bunds, 233,000 ha of hillside terraces for afforestation, 12,000 km of check dams in gullied lands, 390,000 ha of closed areas for natural regeneration, 448,000 ha of land planted with different tree species, and 526,425 ha of bench terrace interventions were completed mainly through Food-for-Work (FFW) program incentives (USAID, 2000).

Compensation for labor, especially in the form of food-for-work (FFW), and in some cases cash-for-work (CFW), has been the main direct economic incentives used for soil conservation in Ethiopia (Gebremedhin, 2004). The programmes were fundamentally top-down, with little involvement of local beneficiaries. Moreover, the programs focused on promoting conservation practices on community lands, with minimal consideration given to individual farms. During this period, it was normal to follow any technical guideline developed and tested elsewhere without integrating it into the local socio-economical or environmental conditions (Shiferaw and Holden, 1998).

Despite the rich indigenous knowledge of soil conservation throughout Ethiopia, the FFW-based soil conservation programmes were aimed at promoting “new” or “improved” soil conservation practices, which were based on little prior research and scientific base. Nevertheless, the achievements fell far below expectations and the country still loses a tremendous amount of fertile topsoil and the threat of land degradation is alarmingly broadening (Gebremedhin, 2004).

The difficulties encountered by the programmes during their initial stage of implementation led to the realization of the need for beneficiary participation in the planning and implementation of conservation programmes and projects, including the adaptation of conservation technologies to local conditions. As a result several participatory approaches were used for soil conservation.

However, the extent of farmer participation and the impact of these approaches on adoption of conservation practices were limited, as real involvement and participation of farmers could not be realized (Gebremedhin, 2004). The lack of prior research and scientific base of the soil conservation programs was also manifested by the little consideration given to conservation needs at the watershed level. The physical appropriate special units for research on resource conservation issue are watersheds. The watershed context provide the natural frame work for investigation into the complex and reciprocal linkage among land use, soil and water resources; the interdependence of people in their resources.

2.3. The Importance of Soil Conservation

The implication of land degradation are extremely important since the livelihood of many Ethiopian entwined with land resources degradation reducing the production potential of land and thus make it difficult to produce enough to feed the growing population. It also increases farmers vulnerability to food shortage and forms a threat to a mere survival of people, The looming food insecurity in the country is mainly linked to the prevailing degradation problem caused by continuous cultivation with limited amendment and wide spread use of dung and crop residue for house hold energy which substantially contribute to the loss of soil organic matter (Aklilu, 2006).

The soil that we use is integral to our livelihood. Most people know that they need clean air and clean water to stay healthy. Fewer people realize that their well being also depends on the health of the soil. Soil supports the growth of most of our food and fiber, so its productivity is a major factor in the overall development of all nations of the world. As a part of development and modernization, trees are cut and vegetation is chopped off, leading to large scale erosion.

Soil conservation is important at this juncture- the soil has to be preserved and the environment kept neat, tidy, and productive in order to preserve our human health and nutrition. The roles of soil conservation in increasing agricultural productivity have been indicated in many studies. Sutcliffe (1993) concluded that physical soil conservation activities are justifiable in moisture-stressed areas of the Ethiopian highlands, where moisture conservation plays an important role in increasing yield. Yohannes (1989) compared barley crop and biomass yields above the bund (soil accumulation area) and below the bund (soil loss area) of Fanya juu terraces in the Andit Tid area of northern Shewa in three cropping seasons from 1986 to 1987. The average barley yield was 1650 kg per ha above the bund, which was 43 % higher than below the bund. Byiringiro and Reardon (1996) used farm-level data in Rwanda and found that farms with greater investment in soil conservation had much greater land productivity than did farms without such investment. Joyce (1999) confirmed that the benefits of soil conservation in agriculture are proven and they offer smallholders the opportunity to increase their productivity, safeguard their land and reduce the risks of total crop failure in drought years. Mou (1996),in his study in loess plateau areas of Yellow basin (China) showed that gully control measures accounted for 45 % of the reduction in sediment yield, terraces accounted for 24% and afforestation for 24%.

2.4. Methods of Soil Conservation

There are no universal conservation practices that work everywhere. Planning soil conservation is like having a large array of techniques and practices set out each in a separate pigeonhole. The object of planning soil conservation is to make up a system by selecting a set of individual items which are each relevant to the conditions, and which can be combined into a workable system (FAO, 1986). People across the world apply different methods of soil conservation according to their land characteristics, degradation extent and technology available. The various methods may be broadly arranged into the following types.

2.4.1. Agronomic (Biological) Soil Conservation Methods

Agronomic measures include mulching and crop management, which use the effect of surface covers to reduce erosion by water and wind (Morgan, 1995). Biological Method primarily involves stimulation of plants growth (grasses, bushes or trees) over the denuded area. Roots of these plants securely bind the soil while the crowns of bushes and trees offer impediments to the flow of air or water currents. Dead plants provide organic material to the soil which in turn improves soil structure and fertility. It is a natural protection by growing vegetation in a manner that reduces soil loss. Different types of material such as residues from the previous crop, brought-in mulch including grass, perennial shrubs, farmyard manure, compost, byproducts of agro-based industries, or inorganic materials and synthetic products can be used for mulching (Lal, 1990). It is effective against wind as well as water erosion. Some such plants as maize stalks, cotton stalks, tobacco stalks, potato tops etc. are used as mulch (a protective layer formed by the stubble, i.e., the basal parts of herbaceous plants, especially cereals attached to the soil after harvest.) Crop residues also reduce the soil temperature by some degrees in the upper centimeters of the topsoil and provide better moisture conservation by reducing the intensity of radiation, wind velocity, and evaporation (Agele *et al*. 2000). It decreases soil loss and preserves the productivity of land (Taffa, 2002). Conservation tillage describes the method of seedbed preparation that includes the presence of residue mulch and an increase in surface roughness as key criteria (Lal, 1990). The practices therefore range from reduced or no-till to more intensive tillage depending on several factors, such as climate, soil properties, crop characteristics, and socio-economic factors (Lal, 1983). This umbrella term can include reduced tillage, minimum tillage, no-till, direct drill, mulch tillage, stubble-mulch farming, trash farming, strip tillage and plough-plant.

In countries with advanced soil conservation programmes, particularly the USA and Australia, the concept of conservation tillage is the main theme of the recommendations for cropland, and it is also being taken up quickly in other areas (FAO, 1986).

2.4.2. Mechanical or Engineering Methods

Until relatively recently, soil erosion has been looked upon largely as a physical problem; the effects of the erosive forces of wind and water on exposed soil. Consequently, there has been a trend to treat erosion as an engineering problem (FAO, 1987)

Mechanical methods, including bunds, terraces, waterways, and structures such as vegetative barriers or stone lines installed on farm break the force of winds or decrease the velocity of runoff to reduce soil erosion (Morgan, 1995). These methods are used as supplements to biological methods. Other methods which check the formation or widening of gullies by constructing bunds, dams, drains or diversions through which excess runoff water is channeled. In addition to these growing vegetation alongside the river bank, to construct drains, concrete or stone pitching etc., for checking the cutting and caving of river banks.

2.5. Factor Affecting Adoption of Soil Conservation Methods

A sizeable body of literature exists which describe and analyses factor affecting soil conservation. Many factors bear on farmers' decisions about adopting soil conservation measures. Following Ervin and Ervin (1982), it is possible to hypothesize the decision making process to adopt soil conservation measures starts from farmers' perception of erosion problem as shown in Figure.1

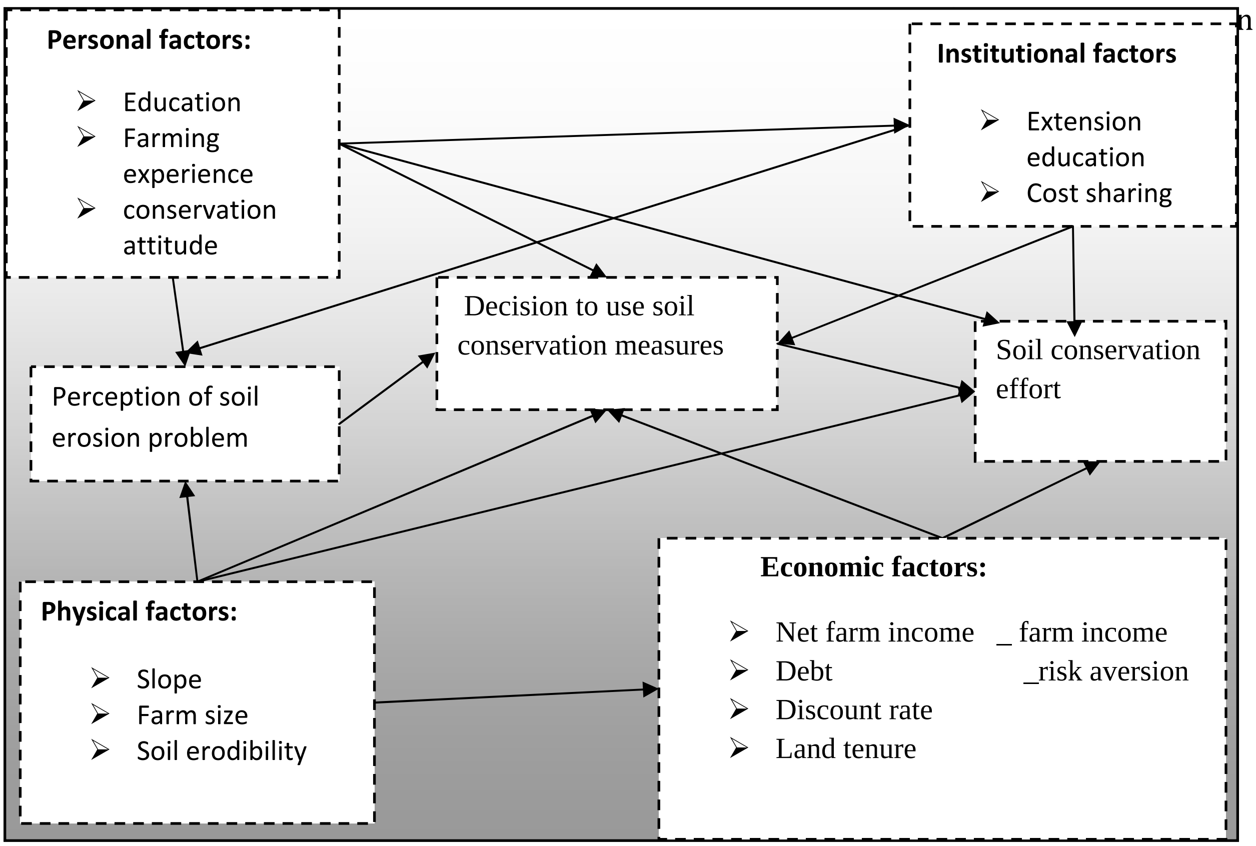


Figure 1: The decision to use soil conservation Source: adopted from Ervin and Ervin (1982).

The theories of adoption and decision making discussed above have included roles for personal, physical, economic, and or institutional factors, but usually not all simultaneously. The adoption and use of soil conservation practices is conceptualized as the decision-making process. Each category of factors is hypothesized to influence one or more of the decision-making process components. Each component can be visualized as a major step in the decision to control erosion.

The process is set in motion by the recognition of an erosion problem. That perception is viewed as a product of the landowner's personal characteristics that might cause a more acute awareness of the seriousness of the erosion (e.g., formal education), coupled with the actual physical characteristics of the land he operates. As shown, government or academic educational programs can be used to heighten the perception of erosion problems. From an economic perspective, perception of the degree of erosion problem and its impact on short-term returns and land values should be highly correlated with the farmer's willingness to pay for conservation measures. Shiferaw and Holden (1998) noted the perception of soil erosion problems, household size, and farmer’s perceptions of technology, specific attributes and land quality differentials as important in shaping conservation decision. Thus, decisions to conserve soil will be influenced by a combination of personal, economic, institutional and physical factors (Arellanes and David, 2003; Enki *et.al*, 2001; John, 2008; Million and Kassa, 2004).

Personal Factors: Personal factors such as education level, farming experience, conservation attitude and family size are factors which influences adoption of soil conservation. Higher education levels are hypothesized to be associated with improved knowledge about conservation measures and the productivity effects of erosion. It can be viewed as influencing a landowner's disposition to use practices because of increased information on erosion control, the productivity consequences of erosion, and higher management expertise benefits and costs. Thus, positive relationships were expected between education and all dependent variables. Farmers' attitudes toward environmental quality and conservation issues should reflect their public concerns about resource use, and consequently, may affect their perceptions of erosion problems and their farm conservation actions.

Those personal characteristics involving acquisition costs can be interpreted as human capital. The degree of physical erosion potential of a farmer's land also may persuade him to choose a particular practice.

Physical Factors: Factors such as farm size, slope, farm terrain, type of erosion, soil amendments, location of farm land and land quality differentials are some physical factors which affect farmers' ability to adopt method of soil conservation (Arellanes and David, 2003; John, 2008; Shiferaw and Holden, 1998).

Economic Factors: Research conducted since the 1950s indicates economic constraints affect the decision to conserve soil. Economic factors may either enhance or constrain farmers' dispositions towards erosion control. For example, high debt levels may inhibit investment in capital intensive terraces, while high net farm income will present tax advantages for the same practice. Educational programs`, technical assistance, and cost sharing are institutional instruments to persuade farmers to use practices. Economic constraints such as wealth status of the farmers, off-farm income, annual income, cost of fertilizer and debt status are factors which tends to increase or reduce incentives for soil conservation (Eleni, 2008; Enki *et.al*, 2001; John, 2008; Million and Kassa, 2004). The final step is the determination of soil conservation effort, a function of the effectiveness and extensiveness of individual practices over the farm's land.

Institutional Factors: Institutional Factors portrays the role of educational and technical assistance programs in affecting perception of erosion problems, decision to use practices, and erosion control effort. In addition to this, institutional factors like secure land tenure right, access to credit and extension training to farmers affects farmer's decision to conserve soil (Eleni, 2008; Gebremedhin and Swinton, 2003).

All factor categories influence effort, but in different ways than they influence the decision to use one or more practices. Personal factors, such as management ability, affect the proper application and maintenance of practices, especially on widely varying topography and soils. Physical factors, which define erosion potential, determine potential productivity benefits over the entire farm unit. Because practices that reduce erosion to a greater degree usually cost more, conservation effort is hypothesized to depend heavily on economic factors and cost-sharing payments.

CHAPTER THREE

GENERAL DESCRIPTION OF THE STUDY AREA

3.1. Location and Topography

Goromti Watershed is found in Oromia region, West Shewa Zone, Ambo Woreda where soil and water conservation is implemented by GTZ – Sustainable Utilization of Natural resource for improved food security (SUN) project. It is 15km far from Woreda capital Ambo town, and 130 km away from Addis Ababa (Figure:2). Geographically, it is located between $8^0$49'26"-$8^0$55'22"N lat. and $37^0$51'57"-$37^0$54'08"E long. The watershed is surrounded Dese Aklilo kebele in the West, Gatira in the East, and Gosu Kora kebele in north, Kiba kebele in the North West and in the South by Southwest Shewa Zone. The watershed is accessed by the gravel road that connects Ambo town with districts and towns of South West Shewa Zone.

The total land area of the Goromti watershed is about 1221 Hactares and composed of mainly Goromti and Ya'i Chebo kebele. The watershed is characterized by undulating, rugged and hilly topography. It has an altitude ranging from 2447 to 3185 m a.s.l (mean above sea level). About 62% of the total area is moderately steep to steep (more than 15% slope), 38% is between gentle and moderate slope (less than 15% slope) (AWARDO (2006).

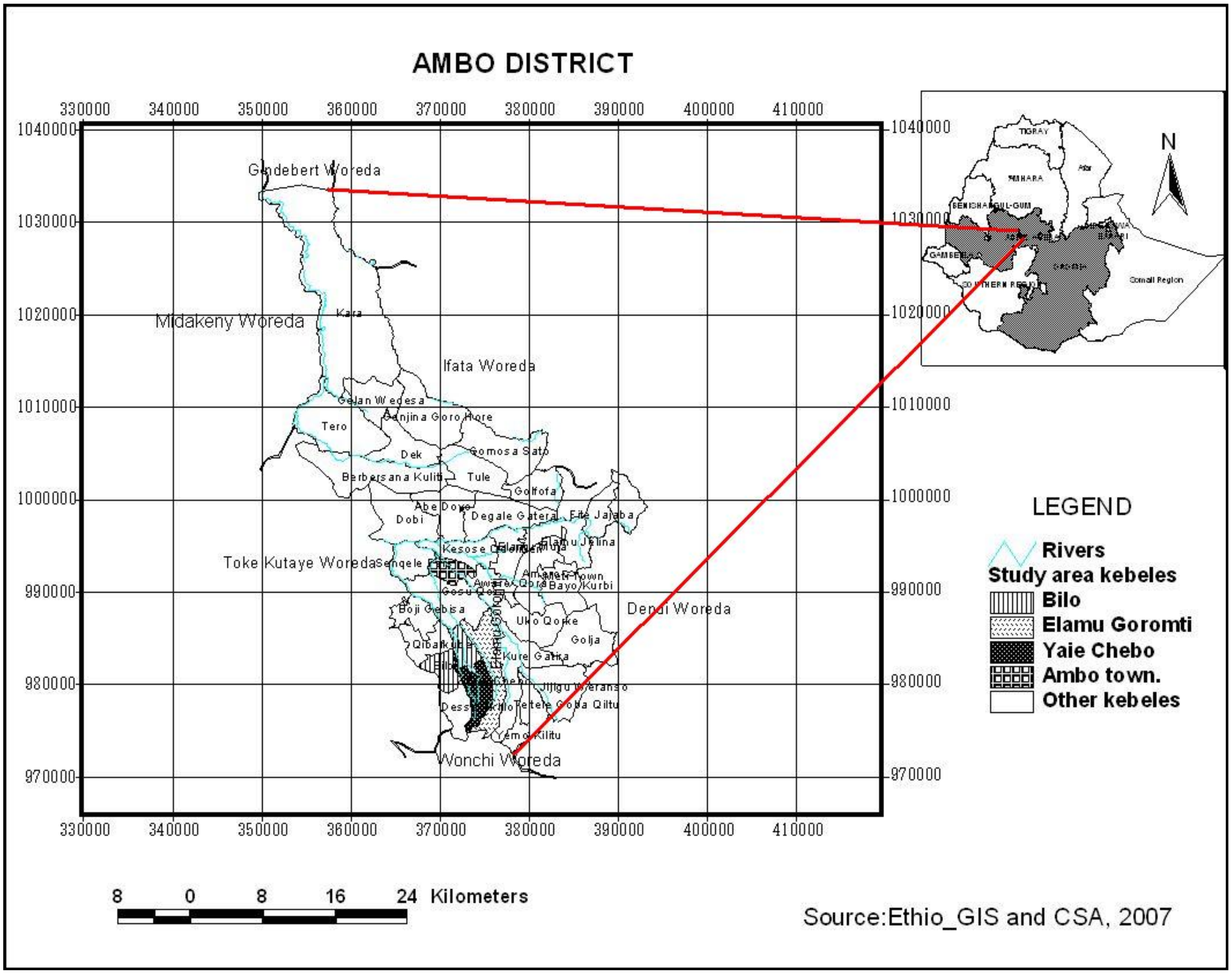


Figure 2: Map of the study area (Developed by Author)

3.2. Geology and Soils

The local geology and its interaction with climate largely determine the nature and type of soil that occurs at ground surface. The geological characteristics of principal importance in this respect include the mineralogical composition of the bedrock, which determines its chemical stability under different climatic regimes. The watershed is covered by Alcalitrachyte sand subordinate basalt.

According to AWARDO (2006), three major soil types dominate the watershed. These are brown soil locally named as *biyyo boralee* which accounts for 70% of the area of the watershed followed by red soil locally called as *biyyo diimaa* covering about 20% and black soil (*biyyo gurracha*) with about 7% coverage and others 3%. According to FAO classification (2006), these soils could be approximated as Haplic Luvisols, Haplic Alisols and Calcic Vertisols respectively.

3.3. Climate and Hydrology

In the study area, the seasonal and spatial variation in temperature depends on altitude. Despite its proximity to the equator, the watershed enjoys a mild temperature condition and is characterized by '*Dega*' agro-climatic zone. The climatic type largely consists of Afro-Alpine temperate and warm temperate climate. The lowest and highest annual average temperature are 13 and 27°C, respectively. The mean annual temperature is 18.6°C. During the dry season, days are pleasantly warm and nights are cool and during the rainy season both days and nights are cool (AWARDO, 2006).

The rainfall of the area is bimodal, with unpredictable short rains from March to April and the main season ranging over June to September. The area is receiving high rainfall ranging from 1500-1700mm. It receives two rains: the main "*Genaa* rains" from June to mid-September and the short "*Arfassa*" rains from February to April. The main rainy season is responsible for 70% of the annual average rainfall of 1,100 mm. It is characterized by intense rainfall of short duration (AWARDO, 2006). April and May are the driest months.

In the catchment, there are two seasonal rivers and many permanent springs. These water bodies are used by both people and livestock. The entire area drains towards the *Uluka*

River which crosses Ambo town which is the tributary of *Guder* stream forming a tributary of Abay River.

3.4. Vegetation

The spatial distribution of natural vegetation depends on many factors among which, climate, drainage pattern and soil types play a pivotal role. In Ethiopia, temperature and rainfall, which largely are altitude dependent, determine the type and density of vegetation (Tewolde-Birhan, 1999). Much of natural vegetation has been destroyed or altered by prolonged cultivation and human settlement. As a result, much of the natural forest, except in some protected areas and along rivers has changed into secondary forest.

Elders affirm that mountainous parts of the study area including the present settlement and agricultural land were once covered with indigenous trees mainly *Juniperus* (Gatira) *Olea abyssinica* (*Ejersa*), *Hagenia* forests (*Heexoo*), acacia (*laafto*), podocarpus (*Birbirsa*) *Arundinaria alpine* (*Shimala*) and *Erythrina Abyssinia (Korchi)*. These are visible here and there witnessing their dominance as indigenous trees of the area in the past. Currently, in addition to these, planted tree species that include *Eucalyptus globulus* (*bargamo adii*), are widely found in the study area. Eucalyptus tree has been planted around homesteads, in between farm boundaries, and as a woodlot by farmers for generation of cash income, fuel and construction material source. Inappropriate farming practices, manifested by cultivation and overgrazing of hillsides and steep slopes, changed forest into cropland and clearing indigenous trees like *Podocarpus* and *Juniperus* coupled with steep and rugged land features have resulted in severe land degradation in the watershed.

3.5. Land use and Economy

Farming system in the area is typically mixed crop-livestock system of the high lands of the country, where livestock provide the drought power needed for farming operation and a good part of crop residue are fed to livestock.

The land use is dominated by crop production. According to AWARDO (2006), 59% of the watershed is cultivated land with arable crops. Where as close to 15% is covered by shrubs and some forests ruminants, 18% is occupied by villages and homesteads and Enset cultivation, 6% by grazing land and 2% of the site contained a degraded hill side that formed gullies.

The major crops grown include barley (*Hordeum Vulgare*), wheat (*Triticum Vulgare*), oat *(avena sativum),* Niger seed (*guizotia abyssinica*), field pea (*Pisum Vativum*), faba bean (*vicia faba*) and root crop like potato (*selenium tuberosum)*. *Enset* (*Ensete Ventricosum)* is the most popular perennial crop grown in all homesteads and serves as staple food and income source of local people. Cattle, equine and sheep are among the livestock reared by the community.

The agriculture practices are traditional and heavily depend on unsustainable agricultural practices where the relationship between people, land and their livelihoods patterns are at imbalance. As observed, the effect of this imbalance is manifested in the occurrence of unsustainable agricultural and natural resource management practices like cultivation of land not suitable for agriculture without appropriate conservation measures, deforestation of natural vegetation (forest, shrubs) and utilizing dung for cooking and heating, degradation and shrinkage of grazing areas, farming practices that facilitate soil and nutrient erosion, and less water infiltration, gully formations reducing the land for productive uses.

3.6. Demographic Characteristics of the Study Area

The total population of Ambo Woreda is 121,317 with a density of 127.8 persons per km^2 (CSA, 2007). The concerned kebeles in the watershed are Illamu Goromti, Ya'i Chebo and Boji Bilo which stretch out within the watershed.

Table 2: Population Characteristics by Sex of Three Kebeles Concerned In Goromti Watershed

Name of kebeles	Population characteristics by sex			Number of households
	Male	Female	Both	
Boji Bilo	1445	1494	2939	601
Illamu Goromti	1621	1596	3217	634
Ya'i Chebo	1375	1406	2781	594
Total	4441	4496	8937	1829

Source: CSA, 2007

From the table 2 there are 4441 (49.6%) are males and 4496 (51.4%) are females. However, the villages in the watershed endowed a total of 3204 inhabitants accommodated in 534 households; with household size of about 6 persons on the average and women headed households constitute 9% of the total households (AWARDO, 2006). The settlement pattern in the study area is nucleated type and is dispersed at village level. Families with children and even members of an extended family may establish their village around farm plots.

1.7. Back ground of Sustainable Utilization of Natural Resources for Improved Food Security (SUN), Objectives and Implementation Strategies

Ethiopia has been heavily dependent on food aid and emergency relief food assistance since a few decades. Much of the food aid has been provided to beneficiaries through food-for-work programs. Emergency relief food assistance and food-aid has however been ineffective in protecting household productive assets and lifting households out of chronic food insecurity. Recognizing this, the Government of Ethiopia has designed policies, strategies and programs that address the food-aid dependency problem and bring about overall economic development in the country.

The major ones include the Agriculture Development-Led Industrialization (ADLI) Strategy, the Rural Development Policy and Strategy, the Food Security Strategy, the Pastoral Development Policy, and the Plan for Accelerated and Sustained Development to End Poverty (PASDEP). The current Food Security Program (2010-2014) which stems from the Food Security Strategy has four major components: (i) the Productive Safety Net Program (PSNP), (ii) the Household Asset Building Program, (iii) the Complementary Community Investment component, and (iv) the Resettlement component. In its efforts to implement the food security program and tackle food insecurity, the Government of Ethiopia collaborates with different bilateral and multilateral organizations. One of these is the German Development Cooperation (GDC). The GDC has been supporting the Government of Ethiopia to implement a conservation and development program, the Sustainable Utilization of Natural Resources for improved food security (SUN) since 2005/06, which is important priority of the country as reflected in the various development policies and strategies mentioned above (SUN, 2010).

The SUN program has been implemented in Amhara, Oromiya and Tigray regions. It is aimed at

I. Introducing technical innovations for agricultural productivity enhancement and efficient utilization of natural resources;
II. Improving rural services and infrastructure including rural roads and irrigation;
III. Enabling rural communities to fully own and independently develop watershed areas; and
IV. Contributing to improvement of the legal and institutional framework for the sustainable utilization of natural resources.

The program is consistent with the food security, environmental conservation, and rural development strategies of the country. It specifically contributes towards reduction of food insecurity problems through asset protection via cash support for community works, asset building by providing improved livestock, forage and crops at household level and development of community assets like spring development, and rural access roads construction. Considered broadly, the intervention is considerably important to the realization of the Millennium Development Goals (SUN, 2010).

Currently, the SUN program covers a total of 94 watersheds in the three regions (25 watersheds in four administrative zones and eight Woredas in Amhara, 28 watersheds, in six administrative zones and 11 Woredas in Oromiya and 41 watersheds in five administrative zones and 22 Woredas in Tigray), which are at different stages of development. The intended beneficiaries are households, farmers' organizations, user groups and staff of public administrative units at federal, zonal and Woreda levels (SUN, 2010).

Implementation Strategy

The SUN is a program of the Government of Ethiopia supported by GDC. It has accordingly been implemented through the existing government structure. At the federal level, the MoARD has the overall implementation responsibility. Within the Ministry, Financial Cooperation (FC) and Technical Cooperation (TC) are managed by the Food Security Coordination Directorate and the Directorate of Natural Resources, respectively. At the regional levels, the respective BoARDs and FSCOs share responsibilities. At the Woreda levels, the WoARDs are responsible for the day to day implementation of the program's activities. With assistance of DAs, communities at the grassroots level are responsible for the site level planning and implementation.

On the part of the GDC, its partner namely GTZ, implement the technical cooperation activities, and KfW is responsible for the financial cooperation. The TC instruments are advising the Ethiopian partner at the macro (federal), meso (regional) and micro (Woreda) levels. Some of the TC activities include the identification of systems that increase involvement of user groups in the management of watersheds, reclaiming eroded lands, soil conservation, intensifying and diversifying agricultural production by developing and disseminating adapted technologies, improving market linkages, developing rural transport, and capacity building works. The FC on the other hand promotes and finances investments in erosion protection measures, small scale rural infrastructure such as roads, spring development, and small scale irrigation facilities. The investment works are implemented by the rural communities themselves.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter deals with the analysis and interpretation of the collected data. An attempt has been made to discuss the state and level of adoption of soil conservation methods in the Goromti watershed and benefits and challenges that farmers met in adopting soil conservation methods. As discussed, field level data i.e. house hold survey, on farm observation interview with natural resource management experts (NARM) and key informant interview with selected farmers were mainly used as major data sources.

4.1. Socio –Economic Characteristics

Population size and characteristics are directly related to the supply and demand condition of basic human necessities which in turn influence the use of agricultural technologies. Hence, examining socio economic and institutional characteristics of sample house hold is paramount importance. To this effect, in the following sections of the chapter the socio economic characteristics of sample households and its effect on adopted methods of soil conservation are discussed.

4.1.1. Demographic Characteristics

4.1.1.1. Age, Sex and Size of Household

Age of members of the household influences overall soil and water conservation efforts of the household. Through experience, farmers perceive and understand the problem of soil erosion and the decline in the fertility of the soil and the use of improved soil and water conservation technology in controlling soil erosion, and add available, organic and/or inorganic fertilizer to preserve and/or improve the fertility of the soil.

Table 3: Age and Sex of respondents Cross tabulation

Age group of respondents	Sex of respondents				Total	
	Male		Female			
	Frequency	Percent of Total	Frequency	Percent of Total	Frequency	Percent of Total
≤ 25	2	1.9	0	0	2	1.9
26 – 45	48	44.9	13	12.1	61	57.0
46 – 65	35	32.7	4	3.7	39	36.4
≥ 66	5	4.7	0	.0	5	4.7
Total	90	84.1	17	15.9	107	100.0

Source: Field survey, 2010

Table 3 shows that out of 107 respondents, about 57% of respondents has age between 26- and 45 years and about 36.4% of sample respondents are between 46 and-65 years followed by 5% and 2% for age above 66 and less than 25 years, respectively. The mean age of sample house hold is about 44.2 year. Concerning to age structure of sample house hold and adoption of soil conservation measures, age group above mean (i.e. > 45) (Appendix B) years adopted physical structures than age group less than 44. This could be due to greatest activity in the use of conservation practices was displayed by middle-aged farmers who were both well established in their farming careers, and still anticipating a number of years in farming. Thus, more experienced farmers (i.e. relatively aged ones) in farming are likely to manage their land better than less experienced farmers.

Thus, possessing the ability and inclination to make investment in the farm business depends on age of a farmer. Even though age of the household and the perception on land degradation were related positively, applying fertilizer and any conservation measure decrease (Fitsum and Holden, 2003).

However, in this study the result of bivariate correlation depicts that there is positive association between age of the household and adoption of conservation methods (Appendix A). The distributions of sample household heads by sex constitute 84.1% and 15.9% for male and female, respectively. Female household heads of the study area are adopters of biological methods of soil conservation than male household heads. This could be due to biological methods of soil conservation are less labor demanding than physical soil conservation methods and biological methods (agro forestry) in the study area were mainly done at garden and homestead farms, whereas physical conservation methods are mainly adopted by male house hold heads (Appendix B). Family size is important parameter as it impinges on labor supply and subsistence requirement. This is due to the increasing demand for food crop with limited land resource. The existence of large number of family members with limited resource could affect land degradation, which in turn affects the farmer to see options for an increase in the land productivity from fragmented plots.

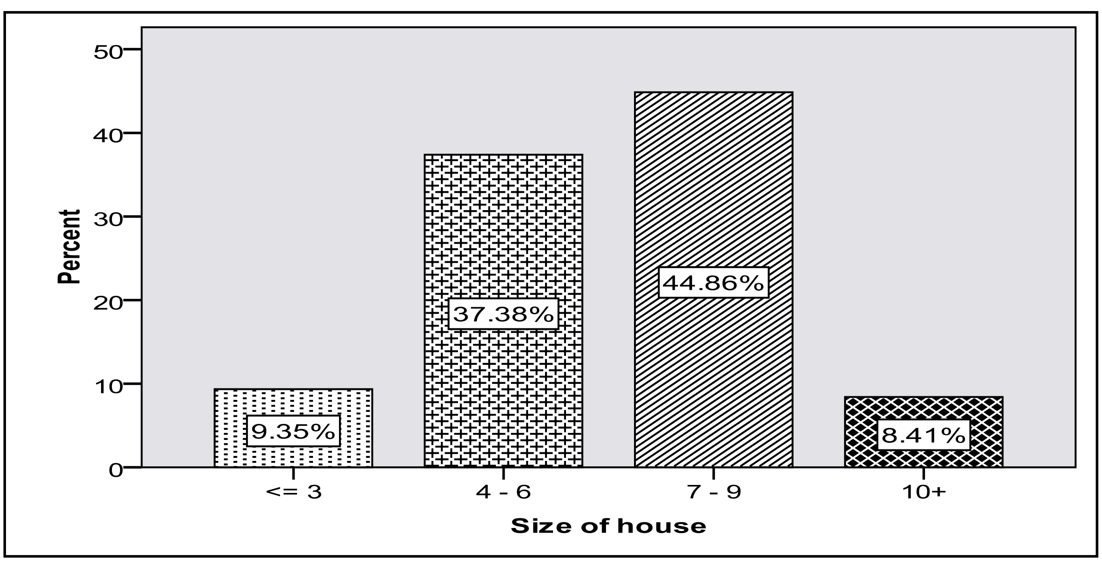


Figure 3: Size of household Source: Field survey, 2010

Figure 3 shows distribution of household size. The table shows that about 44.9% of the house holds have 7-9 members, 37.4% of households have house hold 4-6 persons, and 8.4% and 9.3% have above 10 and less than 3 persons per house hold, respectively. The family size ranges from 1-12 with 6.43 person average sizes per house hold which is greater than the average of the region 5.0 (CSA, 2007). Larger house hold size (6.43) adopts conservation structures (physical conservation structures) more than those with small house hold size. This could be related to labor availability to construct physical conservation measures which are more labor demanding than other conservation methods (Appendix B).

Household size has been identified to have a negative and significant effect on adoption of soil conservation practices in a study conducted in Andit Tid, Ethiopia (Bekele and Holden, 1998). However, in the present study the family size variable has carried a positive sign implying that large household size related with more labor available for conservation activity (Appendix A).

4.1.1.2. Education Level

Low level of education and high illiteracy rate is typical in developing countries like Ethiopia. In fact education level of farmers is assumed to increase the ability to obtain and use of agricultural related information and technology in a better way.

Table 4: Educational level of sample respondents.

Educational level	Frequency	Percent	Cumulative percent
No schooling	62	57.9	57.9
Read and Write	12	11.2	69.2
Elementary	22	20.6	89.7
Secondary	8	7.5	97.2
Higher Education	3	2.8	100.0
Total	107	100.0	

Source: Field survey, 2010

In the study area, 36.4% of the households did not attain formal education and were unable to read and write, whereas about 34.6% of them were able to read and write. The level of education within literate categories was about 18.7%, 7.5% and 2.8% attained elementary, secondary and higher education respectively (Table 4). Education improvements appear to have contributed to several aspects of agricultural intensification and technological adoption, including fertilizers and composting, performing soil conservation measures, planting trees and fences, increase access to information, higher management expertise (Ervin and Ervin, 1982). Hence, it was expected to influence adoption on soil conservation positively (Hartman and Brown, 1970; Nowak, 1987). In this study, the educational level variable has carried a positive sign implying that educational level of sample respondents is associated with adoption of soil conservation methods but was found to be statistically insignificant (Appendix A). Concerning educational level of sample households those who have schooling are adopters of the conservation methods than those who did not attend formal schooling. Biological measures are mainly adopted by those who have formal schooling than those who have not (Appendix B).

4.1.2. House Hold Resource Endowment

4.1.2.1. Size of land and Tenure Type

Land is one of the most important factors of agricultural production. Fig 4 shows that about 46% of house- holds have 1.1-1.5 ha, 28% of sample households have less than 1 ha and about 26% of sample respondents have greater than 1.6 ha. Higher levels of conservation practice adoption are expected on larger farms, as operators should have more flexibility in their decision making, greater access to discretionary resources, more opportunity to use new practices on a trial basis and more ability to deal with risk (Nowak, 1987). The result of bivariate correlation between plot size of sample respondents and soil conservation structures shows that there is insignificant association between them. This could be due to adoption of soil conservation in the study area especially physical conservation structures are mainly depend on slope of farmers plots. (Appendix A and B).

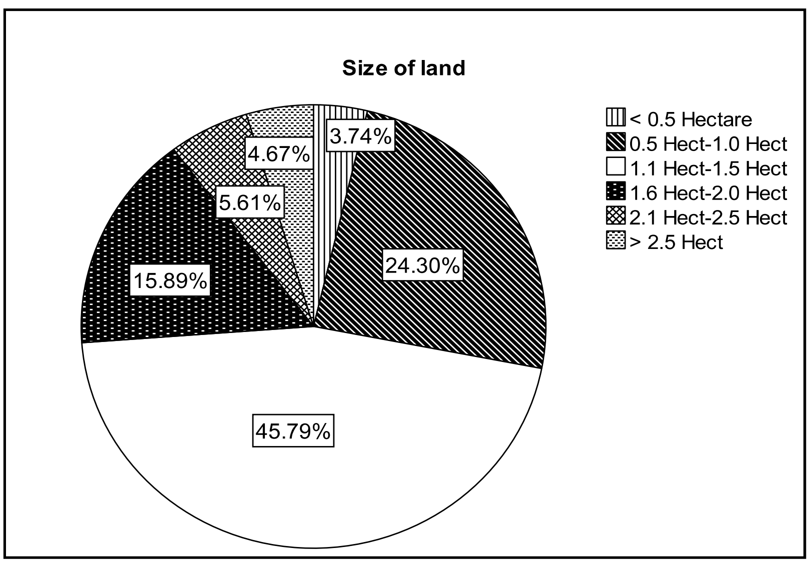


Figure 4: Plot size of sample respondents Source: Field survey, 2010

Evidence from many parts of the world suggests that lack of control over resources is one of the major reasons for the degradation of natural resources.

Figure 5 shows that 90 households (84.1%) of sample respondents tenure status is owner and the remaining 12 (11.2 %) and 5 (4.6 %) were shared and rented, respectively. This shows that the majority of farmers are owners of the land and secured right to use their land.

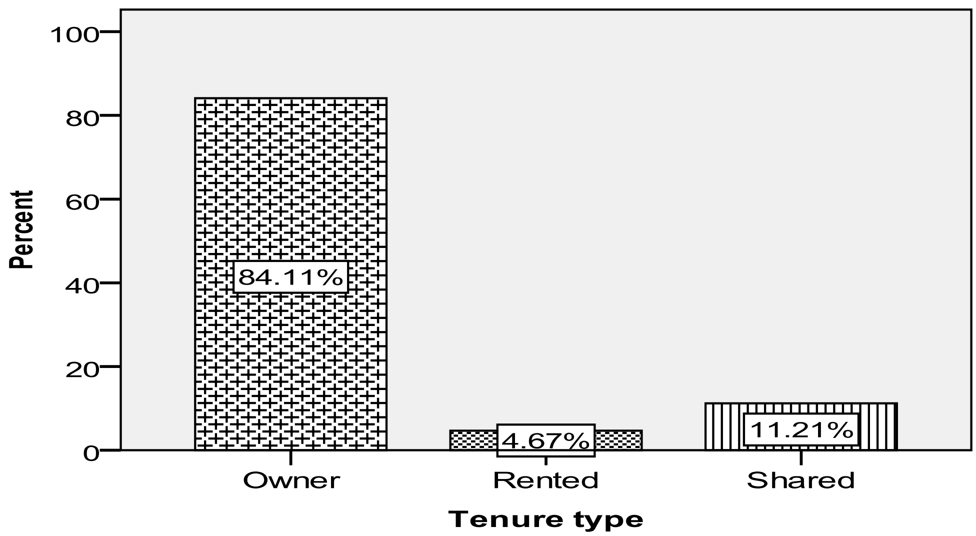


Figure 5: Tenure types of sample respondents Source: Field survey, 2010

Tenure security determines the extent to which farmers may benefit from investments made to improve the land. The greater the risk of losing the right, the less likely they are to invest, or conserve the productive capacity of the land (Feder et al., 1988).In the extreme case, in which farmers expect to hold land for only the some seasons, they will have no incentive to invest; rather, their incentive is to get the maximum benefit that they can from the land, even if it is undermining its future productive capacity. Studies of the effect of tenure on the adoption of innovations have generally held that renters of farmland are less likely to invest in soil conservation measures because of a lack of commitment to maintaining the long-term productivity of the soil (Ervin and Ervin, 1986).

The result of bivariate correlation between tenure status and adoption of soil conservation method shows that there is positive relationship between tenure status of sample respondents and adoption of soil conservation methods but statistically insignificant (Appendix A).

4.1.2.2. Livestock Holding

Traditionally, livestock in the study area have been kept for different purposes. They are kept to provide food, as draft and transport, as a means of assets because farmers regard livestock as a safeguard for sudden cash requirement as they represent a considerable capital resource. These animals are sold in time of need for food, credit payment for taxes and others.

Table 5: Livestock population of sample house hold

Livestock types	Minimum	Maximum
Calf	0	3
Cow	1	6
Equine	0	3
Goat	0	7
Oxen	0	6
Sheep	0	31

Source: Field survey, 2010

Oxen are kept both for ploughing and fattening purpose. Because animals are used in the farm operations, complimentarily between crop production and livestock enterprise is a common phenomenon of smallholder farmers of the study area. They interact with each other in that animals provide farm power and cow dung in exchange for forage from the crop residues and by-products. Livestock has been blamed for land degradation in Ethiopia. Research has generally shown that as vegetation cover declines under heavy stocking rates, the water infiltration rate decreases and sediment production increases. From the table 4 one can conclude that there are many live stocks in the study area. Sheep (1002) outnumbered other farm animals (Table 5). This is due to the climatic factors. Cooler temperature, due to its high altitude and topography creates favorable condition for animals like sheep than the others. Livestock in the area is blamed for removing physical conservation structures.

This is mainly due to they graze freely on farm plot after crops harvest. As to animal forage, communal grazing areas, private pastures and crop residues are the principal source of feed for their live stock in the watershed. In addition to this, some farmers purchase industrial by-product to feed their livestock.

4.1.2.3. Farm Plot by Slope

Slope is an indicator of the likelihood of erosion on the land. The slope of a plot also affects the adoption of conservation structures because the steeper the slope, the more likely the land will be exposed to erosion. Hence, it is believed that adoption of physical structures tends to be likely on steeper slopes.

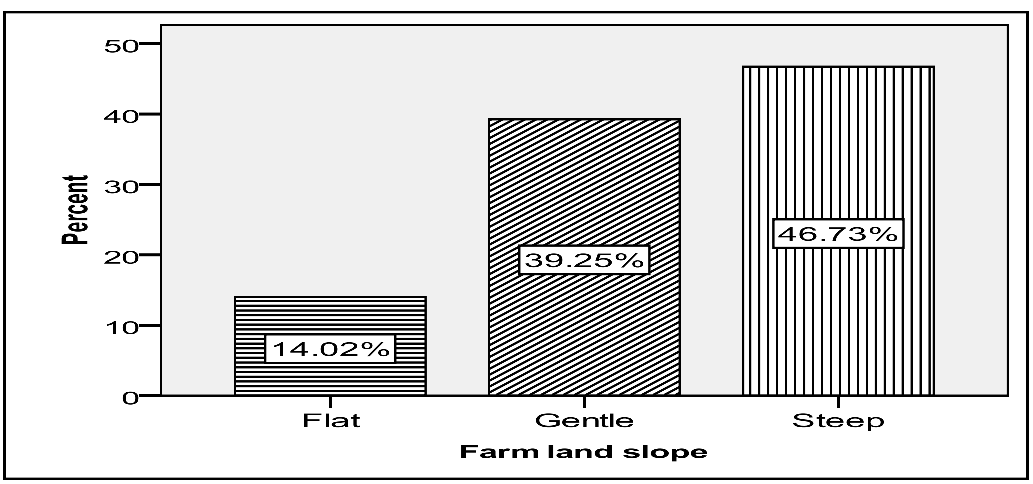


Figure 6: Farm plot slope characteristics of sample respondents Source: Field survey, 2010

Figure 6 indicates that out of total sample respondents 50 (46.7%) of sample respondents farm plot is located on steep slope "*Lafa hallayyaa*" and about 42 (39.3%) found in gentle "*Lafa randa*" and the rest 15(14%) farm plot located on flat "*Lafa diriraa"* slopes. This shows that the majority of sample respondent's farm plot is found on gentle to steep slope which is susceptible to erosion. Lapar and pandey (1999) in the Philippines found that the slope of a plot to be one of the factors significantly influencing the adoption of soil conservation. Their results suggest that a farmer who operates a field with steeper slope is more likely to adopt the contour hedgerow technology. Wagayehu and Drake (2003) also found similar results. But, Alemu (1999) found statistically significant and negative relationship between slope and participation in conservation investment. He argued the returns from investment on steep sloped plots might be low, hence less adoption on such plots. However, in the present particular study, the result of bivariate correlations indicates that slope of a plot has been identified as a major factor that influenced farmers' adoption of soil conservation methods positively and significantly (Appendix A).

4.1.3. Access to Institution and Basic Infrastructure

Information about new technology can be obtained through different ways, such as visiting demonstration fields, participating in formal or informal trainings, watching television and contact with extension or development agents. Agricultural extension system in the study area offers a multitude of activities such as training visit, arranging field days organizing demonstration trial etc. The effort to disseminate new agricultural technology is mainly successful if there is effective dissemination of agricultural information through provision of training.

Table 6: User of fertilizer, credit scheme, seed variety and sufficiency of seed supply

	Alternatives	Frequency	Percent
Fertilizer users	Yes	96	89.7
	No	11	10.3
Total		107	100
User of credit	Yes	48	44.8
	No	59	55.2
Total		107	100
User of seed variety	Yes	65	60.7
	No	42	39.3
Total		107	100
Sufficiency of seed supply	Sufficient	12	11.2
	Insufficient	95	88.8
Total		107	100

Source: Field survey, 2010

Institutions are the rule of the game of development endeavor. In rural area one can easily find a number of locally available institutions with varying objectives and degree of comprehensiveness. In the study area *Debo, Edir, Mahiber* and *Equb* are the most common rural institutions. Now days a number of modern rural institutions are increasing over time, too. Rural credit institutions play a leading role in the development arena of the study community.

Credit availability has a paramount importance to improve the ability of the households at critical times of year to buy inputs. Availability of credit and modern inputs is an integral part of the extension system required to increase agricultural production through the use of modern agricultural technologies like fertilizer, improved seeds, farm implements, etc. The major source of credit in the study area is non governmental organization called Netherlands micro finance institution. Furthermore, farmers obtain credit from informal sources mainly from relatives, friends and local lenders. The results of the key informant interview indicate that there is adequate credit service available in the Woreda especially in the watershed. Table 6 shows that about 44.8% of farmers use the credit scheme which is too low. The money borrowed is used to solve their cash constraints, which is mainly used for paying student fee and buying fertilizer and oxen and other fattening ingredients for their cattle. Attitude towards using credit scheme is low. This might be due to either there is lack of awareness to use credit scheme or farmers attitude to the scheme is not good. In addition to this about 60.7% replied that they used seed variety mainly barley and wheat which is insufficient 88.8% in supply (table 6).

4.1.3.1. Access to Extension Services

Agricultural extension is of paramount importance to introduce better agricultural practices and improved technologies to smallholder farmers in a country like Ethiopia where traditional practices are dominating. In the study area, like the other district of the region, the office of Agriculture through its technical experts and DAs at community level provides agricultural extension. The agricultural extension services in the study area mainly focused on providing basic agricultural education, teaching, and demonstration about the use of agricultural inputs, forestry development, soil conservation and livestock production aspects. The survey result indicated that 91.6% of the respondent has access to agricultural extension agents. As far as frequency of extension contact is concerned, it is apparent from the table 7 that about 59.8 % had extension contact once per month, and about 25.2% adopters had extension contact twice per month and about 6.5% has three times per month contact and the rest 8.4% has no contact with extension workers (Table 7).

From this table, one can simply understand adopters had various levels of extension contact. During the field survey, the researcher confirmed the existence of three extension workers (development agents) assigned to work in the study area. The key informant interviewees did not deny the existence of development agents in their respective kebele. However, some of the informants were doubtful the capacity of development agents in providing the necessary extension services. Access to information is very crucial in the progress of technology transfer since it improves farmer's knowledge about new technology which can further influence the attitude of farmers towards adoption. The result of bivariate correlation between contact with development agents and adoption of soil conservation depict that there is a positive and significant relation between contact with extension agents and adoption of soil conservation methods (Appendix A).

Table 7: Contact frequencies by sample respondents

Contact frequency	Frequency	Percent
Once per month	64	59.8
Twice per month	27	25.2
Three times per month	7	6.5
Has no contact	9	8.4
Total	107	100.0

Source: Field survey, 2010

Table 7 shows that about 89.7% of sample respondents have visited different demonstration concerning construction of physical structures (mainly *fanya juu*, soil bund, water way and cut off drain) and preparation of soil management measures like compost. This result implies that there is significant contribution of visiting demonstration and adoption of soil conservation method in the study area.

This could be explained by the fact that there are adequate demonstration sites in the study area. About 80.4% (table 8) of the adopters have access to agricultural technology related training. The effort to disseminate new agricultural technology in the study area is successful and there is effective dissemination agricultural information through provision of training. The results of the study clearly depict that training and visiting demonstration regarding soil conservation methods has great contribution in adopting methods of soil conservation. The result of bivariate correlation depicts that there is positive and significant association between access to training and visiting demonstration with adopted methods of soil conservation in the study area.

Table 8: Visiting Demonstrations and Training Cross tabulation

	Alternatives	Farmers Training				Total	
		No		Yes			
Visiting demonstrations		Freq	% of Total	Freq	% of Total	Freq	% of Total
	No	5	4.7	6	5.6	11	10.3
	Yes	16	15.0	80	74.8	96	89.7
Total		21	19.6	86	80.4	107	100.0

Source: Field survey, 2010

4.1.3.2. Access to Basic Social Infrastructure

Road is one of the most important physical infrastructures that facilitate movement of peoples and goods from one place. But the length and quality of roads in the study area remains very low. There is one gravel road which connects the watershed with Ambo town and Haro.

Telecommunication service is one of the fast and effective ways of transmitting both business and administrative information, especially in areas where road transport system is under developed. However, the study area has no such access.

The study area get water supply from underground water of deep drill and springs developed by GTZ micro project and river in the watershed. In the watershed as many other parts of Ethiopia the major sources of energy are charcoal, animal dung, crop residue and firewood.

Table 9: Source of energy by sample respondents

Source of energy	Responses		Percent of Cases
	Frequency	Percent	
Crop residue	13	6.2	12.1
Animal dung	89	42.6	83.2
Forest wood	107	51.2	100.0
Total	209	100.0	195.3

Source: Field survey, 2010

As shown in Table 10, all sample respondents (100%) use forest wood as a source of energy and 83% of them also use animal dung as a source of energy whereas crop residue is used by 12% of sample respondents. Crop residue is used as a source of energy, as a source of cash and animal feed. Obviously, agricultural production is negatively affected by the use of crop residue for these purposes instead of using it as a means of increasing organic fertilizer. All farmers in the area are well aware of the importance of dung and crop residues to improve soil fertility. Respondent farmers also indicated that shortage of fuel wood and feed for animals were the main causes for using dung and crop residues for fuel instead of using it as manure. However, a few of them had attempted using the dung as organic fertilizer.

Income from selling cow dung and crop residues were the other reasons that blocked the use of these traditional fuel sources as organic fertilizers. Kerosene and candle were used only for lighting purposes during night. Health institutions comprise the very basic parts of social services. Concerning the distribution of health institutions in the study area, there are one clinic and one veterinary service in the watershed.

4.1.4. Farmers Perception on the Existence, Cause and Consequence of Soil Erosion

Farmers were asked on existence of soil erosion in their farm land and off farm. Almost all farmers replied the presence of soil erosion in their farm plot. They also reported existence of non-erosional soil problems such as loss of fertility. All of the sample respondents perceived the problem, its severity and the outcome of land degradation in the study area. Table 11 shows that about 93.5% of sample respondents replied that steep slope cultivation is the major cause of soil erosion in the study area followed by high rain fall, deforestation , continuous cropping without fallowing, population pressure on resources and over grazing contributing 88%, 86%, 77%,70.1% and 68% as the major causes soil erosion, respectively (Table 10).

Table10: Famer's perception on causes of soil erosion in the study area (multi response)

Cause of soil erosion	Responses		Percent of Cases
	Frequency	Percent	
Rain fall	94	16.4	87.9
Intensive cultivation (less fallow)	82	14.3	76.6
Overgrazing	73	12.7	68.2
Absence of crop rotation	28	4.9	26.2
Steep slope cultivation	100	17.4	93.5
Deforestation (agricultural land expansion)	92	16.0	86.0
Absence of organic fertilizer application	30	5.2	28.0
Population growth	75	13.1	70.1
Total	574	100.	536.4

Source: Field survey, 2010

Ervin and Ervin (1982) confirmed that farmers who operate land which is inherently more susceptible to erosion problems are thought to have a greater propensity to adopt conservation practices. Thus, it is possible to conclude that the problem farmer's face enforced them to adopt new methods of soil conservation. Perceiving the problem provides stimulus to adopt conservation practices that stop the problem (Long, 2003)

Table 11: Perceptions of farmers on consequence of soil erosion

Consequence of Soil Erosion	Responses		Percent of Cases
	Frequency	Percent	
Yield decrease	101	18.4	97.1
Land reparation become difficult	95	17.3	91.3
Migration	81	14.8	77.9
Change type of crop grown	83	15.1	79.8
Land become out of cultivation	95	17.3	91.3
Reduce land size	94	17.1	90.4
Total	549	100.0	527.88

Source: Field survey, 2010

Almost all farmers understand the decline in the fertility of their plots before adoption. This is due to low adoption of improved soil and water conservation practices, miss management of farmland, deforestation, overgrazing, etc.

Table 11 shows that out of sample respondents, almost all (97%) perceived that soil erosion results in a decline in the productivity of plots by decreasing soil depth and (91%) a change in the pattern of the crop production, Land preparation became difficult to some extent and cultivated land becomes out of production. About 90% believed that it reduces plot size that result from gully formation caused by severe erosion and 78% replied that migration will increase off-farm activities to fulfill the household demand.

4.1.5. Participation

Regarding participation of farmers in soil conservation measures, Table 12 indicates that most (88.8 %) farmers were voluntarily participating in soil conservation activities. About 11.2% participated unwillingly only to fulfill local government orders. Farmers participate from identification of problem to implementation stage; this is mainly due to the down to top approach followed by the project. In this particular analysis participation is to mean genuine cooperation of beneficiaries right from identification of soil conservation methods to final stage i.e. selection, prioritizing, designing, implementation and evaluation.

Table 12: Ways of participation by sample respondents

Ways of Participation	Frequency	Percent
Voluntary	95	88.8
Un voluntary	12	11.2
Total	107	100.0

Source: Field survey, 2010

Natural resource management experts of the Woreda and development agents described that conflicts were common between the technical interest of the project and the interest of farmers during implementation of physical conservation structures. Conflicts arose usually on bund spacing at the beginning of the project, farmers being not happy with construction and closely spaced soil bunds mainly due to labor shortage and more use of land. However, the problem is resolved later through training and awareness creation. Elsewhere in Ethiopia lack of beneficiary participation and following of top down approaches were major reason for the failure of conservation methods (Million, 1996). In general, the introductions of soil and water conservation measures in the study area with full awareness helped in overcoming the problem coming at adoption stage and ensure sustainability. Thus, voluntary community participation is one of the factors assumed in this study as it is largely influencing adoption of soil conservation methods.

4.1.6. Major Agricultural Problems

All sample farmers were asked to identify the major problems of agricultural production in their area. The major problems identified by respondents included high fertilizer cost (100%), heavy rainfall (91.6%), land fragmentation (shortage of land) (90.7%), rainfall variability (coming late and ending earlier) (85%) and lack of improved seed supply (80.4%) (Table13). Farmers strongly suggest that their farm plots are unable to produce without the use of inorganic fertilizer. From Table 13, it is evident that a single plot could have one or more problems that are interdependent and equally important.

Table 13: Farm land problems in the study area.

Farm land problem		Responses		Percent of Cases
		Frequency	Percent	
Alternatives	Heavy rain fall	98	17.5	91.6
	Rain fall variability	91	16.3	85.0
	Prevalence of insects	28	5.0	26.2
	Prevalence of rodents	53	9.5	49.5
	Land fragmentation	97	17.3	90.7
	High fertilizer cost	107	19.1	100.0
	Lack of improved seed supply	86	15.4	80.4
Total		560	100.0	523.4

Source: Field survey, 2010

4.2. Indigenous and Adopted Method of Soil Conservation of Sample Respondents

4.2.1. Indigenous Method of Soil Fertility and Conservation Measures

Soil erosion in Ethiopia has physical, social and economic dimensions. It is one of the causes for the increased in the price of food grains and other agricultural products both in rural and urban areas which ultimately results in lowering the living standard of population. In an attempt to tackle the problem of land degradation, farmers developed several indigenous technologies since ancient days. Farmers in Goromti watershed have been practicing certain combination of modern and traditional methods of soil conservation.

Several traditional soil fertility maintenance techniques have been identified in the area. These include "*Kosii fi dikee naqu (manuring*), Lafa baasuu (fallowing) and *Bo'oo baasuu* (traditional water way). In the past since farmers used to have a large number of cattle and area of land, *Kosii fi dikee naqu, (manuring)* and *Lafa baasuu (*fallowing) were the major practices for soil fertility maintenance.

Lafa baasuu (Fallowing): It is a practice of abandoning land for upgrading when the nutrients are exhausted. Fallow land is commonly used as a grazing ground for five to seven years depending on land holding of the farmer and the nature of the land to recover. However, due to population pressure, which resulted in reduced land holding and hence limited grazing ground, leaving a land fallow have gradually become difficult. Hence, the use of such practices is highly challenged. Nevertheless, some of the practices are still visible as a persistent means.

Bo'oo baasuu: (Traditional water way): This structure is constructed mainly by oxen drawn plough, but depending on the runoff expected, which depends on the slope length and gradient, intensity of rainfall and the type of crop planted upstream of the field, re-enforcement by hoeing may be necessary. The quality of these measures indicates whether or not the farmer is active. An active farmer monitors what happens at the up stream or neighborhood of his field. He should follow what crops are sown and the direction of Bo'oo of the neighboring farmers and up stream of the field in order to implement necessary measures. Semi-parallel drainage furrows known as "Bo'oo' is constructed at relatively closer interval depending on the slope.

Kosii fi dikee itti naquu (Manuring): It is a practice of spreading households' wastes to the field for soil fertility maintenance. 'Kosii, which literally means waste, consists of all kinds of human and livestock residues in and around the residence. This practice undertake mainly in those house hold that have many livestock. They spread on farm land which is near to residence.

4.2.2. Adopted Techniques of Soil Conservation

It was since 1980s where SWC methods introduced in the study area. These measures can be categorized into three based on the land use type in which they were applied. These are conservation measures on farmlands, conservation measures on hillsides and conservation measures on degraded lands (to rehabilitate gullies). Most of soil and water conservation effort made in the area was directed in controlling soil loss from cultivated fields.

Many of soil and water conservation measures introduced to the area are mechanical conservation measures. These include soil bunds, water way, cutoff drain and *fanya juu*. However, it is not usual to see stone bunds or stone faced bunds due to scarcity of stone, which is attributable to geological feature of the study area. It is only in few places that terraces are constructed in the study area. The biological measures introduced in the area were grass strips, revegatation, and compost and area closure. Note that In this particular discussion *Adoption is defined as the decision to use a new technology or practice by economic unit on regular basis and Adopters are farmers who use (practice) at least one techniques among newly introduced.*

Table 14: Adopted Techniques of Soil Conservation

Adopted Techniques of soil conservation	Responses		Percent of Cases
	Frequency	Percent	
Soil bund	78	12.7	73.6
Fanya juu	93	15.2	87.7
Cut off drain	102	16.6	96.2
Water way	66	10.8	62.3
Grass strip	83	13.5	78.3
Live fence	39	6.4	36.8
Revegetation	52	8.5	49.1
Area enclosure	44	7.2	41.5
Compost	37	6.0	34.9
Agro forestry	19	3.1	17.9
Total	613	100.0	578.3

Source: Field survey, 2010

Soil bund: soil bund is an embankment constructed from soil along the contour with water collection channel or basin at its upper side. It is constructed by throwing soil dug from basin down slope. It is used to control runoff and erosion from cultivation fields by reducing the slope length of the field which ultimately reduces and stops velocity of runoff. Usually it is constructed in fields that have slope greater 10%. Table 14 shows that 73.6% adopted the structure on their farm plot. This conservation structure is mainly constructed by development team in the watershed. According to WFP (2005), it is effective in controlling soil loss, retaining moisture and ultimately enhancing productivity of land.

Figure 7: Soil bunds

Fanya juu: (a Swahili term meaning "to throw up") is a soil bund type where in a ditch is dug along the contour and the soil is thrown up to form a ridge above; a natural bench terrace will subsequently form over the next few years (IFPRI, 2007). They are usually constructed in the fields sloping above 10%. Table 14 shows that about 87.7% adopted fanya juu on their farm plot. The construction of *fanya juu* takes less space than soil bunds and accelerate bench development, thus, complaint about space can be greatly reduced with *fanya juu* terraces (WFP, 2005). The *fanya juu* reduces or stops the velocity of over land flow and consequently soil erosion. Experts from AWARDO indicated that crop beneath *fanya juu* terraces does not suffer from shortage of moisture since it serves as underground irrigation.

Figure 8: Fanya juu

Revegetation: revegetation is the system of forage establishment on land with an un satisfactory vegetation cover. Such lands can be newly constructed bunds; cut of drains, water way degraded land and gullies. Table 14 shows that about 41.9% of sample respondents were practicing revegatation on their farm plot. Plants such as grass, legumes and selected trees and bushes are planted for their multi purpose use. Revegetation is most effective way of soil conservation grasses also helps to stabilize bunds and other structures. They are very effective if cattle are excluded from grazing all the year. Revegatation provides forage which is essential for live stock.

Grass strip: is a ribbon like bund of grass laid out on cultivated land along the contour. Usually grass strips are about 1m wide and spaced at 1m vertical. They are mainly used to replace physical structure on soil with god infiltration on gentle slopes. Grass strip helps to reduce run off and filter out sediments carried by run off and stabilize fanya juu and soil bund in farm plot. If grass strips grow, it will effectively build up into terrace and provide cattle fodder. The majority of farmers 78.3% (table 14) adopted this method this is due to they are less labor demanding as well as they are mainly planted on soil and fanya juu as bund stabilizer and Table 15 shows about 78.3 % of farmers practiced grass strip on their farm plot.

Figure 9: A typical revegatated gully by trees (left) and Grass strip (right).

Cut off drain and Water way: They are channels used to collect run off from the land above and to divert it safely to a water way or river; thus protecting the land below from excessive erosion. This structure is adopted by the majority of farmers 96.2% (table 14) of farmers this could be due to the structure is ease to construct and applied to all cultivated land. They are constructed along the slope, often covered with grass to prevent destruction, and primarily installed in areas with high rainfall rates (Morgan, 1995). The farmers construct these drains to prevent loss of seeds, fertilizers, manure and soil due to water flowing onto the plot from uphill. The excess water is disposed away from the field. However, according to farmer opinions, some of the traditional drain structures enhance soil erosion through time.

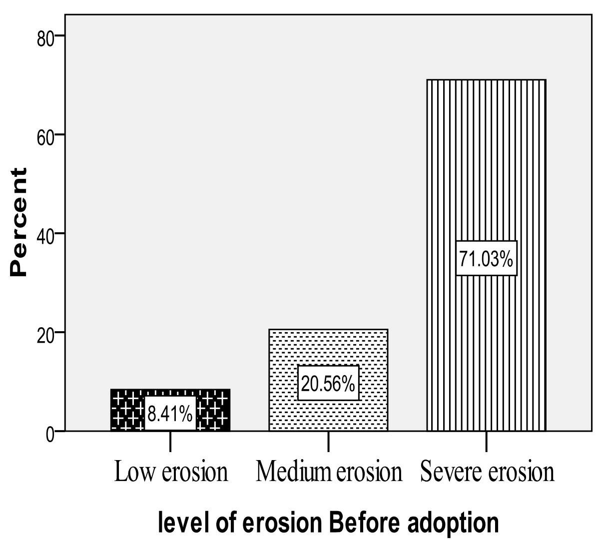
Figure 10: cut off drain (left) and Waterway (right).

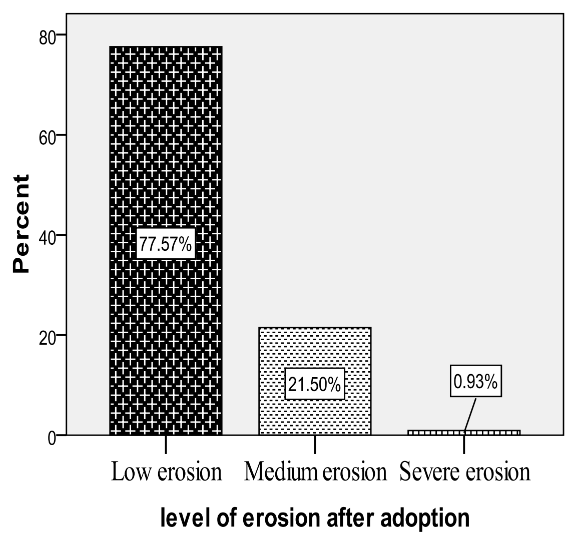
Waterways are especially vulnerable to erosion because of the concentrated flows they need to accommodate. They should be carefully designed, constructed, stabilized and maintained to reduce the risk of failure by gullying or by overtopping. They are designed by taking into account the size of the catchment area, soil type, land slope, land use, and expected grass cover in the channel. Soil conservation waterways usually rely on a lining of vegetation to give protection from erosion. Vegetation protects the channel by reducing the velocity near the bed and covering and binding the soil together.

Biological conservation methods such as area closure, live fence and agro forestry were adopted by 41.5%, 36.8%, and 17.9% farmers respectively. This is mainly due to related to scarcity of land (area closure is mainly practiced by farmers whose land is highly eroded and those who owned some what large land (this is because to protect one land with out cultivation takes3-5 years to rehabilitate it self) which one farmer with small land holding could not afford (interview with NARM experts). Agro forestry is mainly practiced at garden level which is also takes long time to give benefit which farmers need immediate benefits (to gather fruit of apple tree it takes 2-3 years).

4.3. Benefits of Adopted Method of Soil Conservation

The higher the pressure on farmers and the bigger the problems for them to carry on with their business, the easier it is to introduce a change. Farmers who are satisfied with their situation are reluctant to change. Obviously the project implementation has to make sure that the capacity building component is well enough established to allow for long term sustainability.





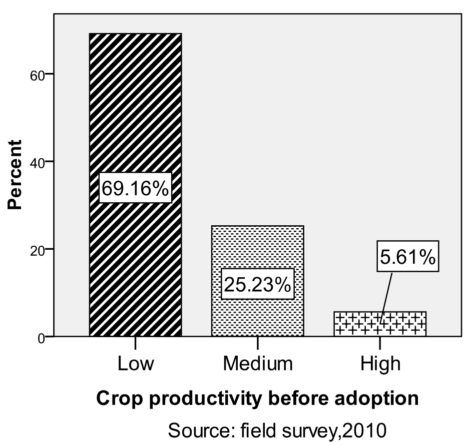
Source:field survey, 2010

Figure 11a: Level of erosion before adoption Figure 11b: Level of erosion after adoption

Figure 11a shows that out of total respondents 71% replied that the level of erosion before adoption is severe followed by 20.6% medium erosion and the rest 8.4% low erosion. The level of erosion after adoption is low (77.6%) followed by 21.5% medium and the rest (1%)

is insignificant Figure 11b. Thus, it is possible to conclude that the overall adopted method of soil conservation method in the study area in arresting soil erosion is effective.

Farmers were also asked to compare the extent of productivity before and after adoption of soil conservation methods. Figure 12a shows that about 69.1% of sample respondents replied that the level of crop productivity before adoption is low followed by 25.23% medium and 5.6% low. This is due to their level of traditional soil conservation methods is less effective and their reliance on adopted method of soil conservation like fertilizer application is extremely low. In addition to this the result of key informant interview indicates that moisture content of the soil is increasing from time to time. The result of study by Hengsdijk *et al*. (2005) also confirm that soil conservation can improve moisture retention during low-rainfall periods and thereby reduce moisture stress and enhance plant growth.



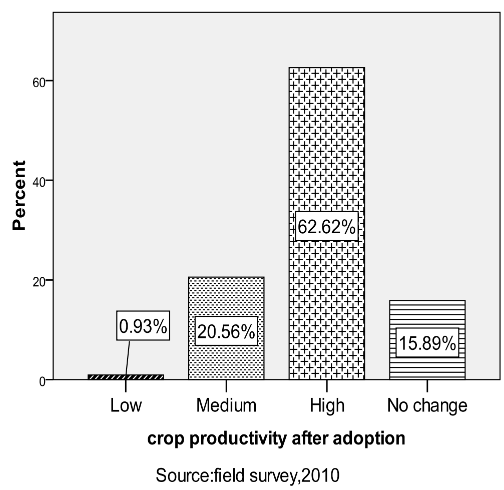
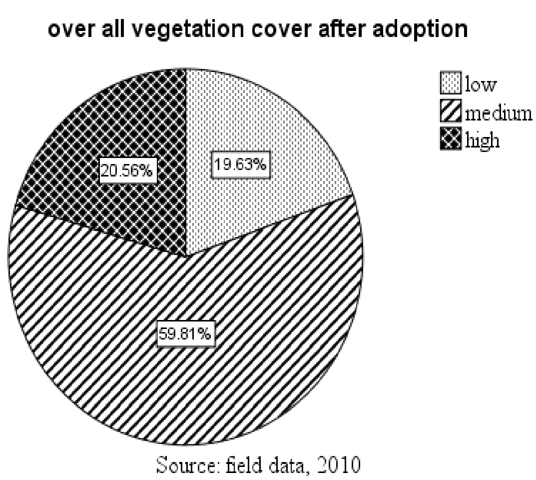


Figure 12a: Crop productivity before adoption Figure 12b: Crop productivity after adoption

Accordingly, about 62.6% of sample respondents replied that the level of crop productivity after adoption is high, 20% medium and 15.8% no change (figure 12b). This is due to the adopted method of soil conservation is effective in increasing the crop yield. Farmers confirmed that before construction of soil conservation structures the use of inorganic fertilizer did not result in increasing yield.

This was ascribed to that erosion washed away the top soil together with the applied fertilizer leaving behind the poor and eroded soil. Thus, from this one can conclude that supply of improved crop variety, fertilizer application must be coupled with physical structures adopted to increase crop yield in the area. Benin (2006), based on a survey of 434 households representing the highlands of the Amhara region as a whole, found that stone terraces had significantly positive impacts (a 42 % increase) in lower-rainfall parts of the Amhara region.

Pender and Gebremedhin (2006) conducted a survey of 500 households representing the semi-arid highlands of Tigray, and found that higher crop yields from plots with stone terraces (an average yield increase of 23 %), and estimated the average rate of return to stone terrace investment to be 46 %.



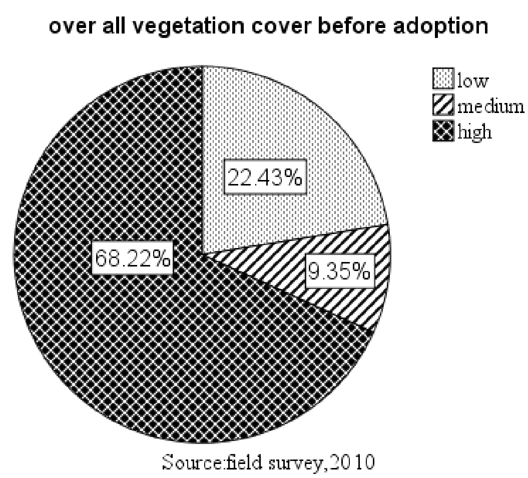
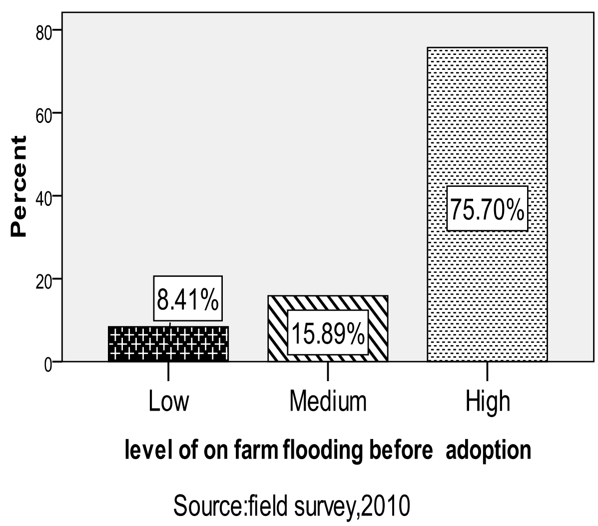


Figure 13a: Over all vegetation cover before adoption   Figure 13b: Over all vegetation cover before after adoption

Figure 13a shows that the over all vegetation coverage of their area before adoption of soil conservation was high (68%), whereas the over all vegetation coverage after adoption is medium (59.8%). Farmers replied that the vegetation coverage is medium (22.4%) and high (20.6%) before and after adoption respectively (figure 13b). The result of observation and key informant interview confirmed that because of deforestation and agricultural land expansion the over all vegetation coverage in the area is decreasing. However, because of project intervention some degraded hill sides are covered by some indigenous and exotic tree species. In addition to this, farmers were given seedlings from nursery site available in the watershed to plant on their farm plot and out side their farm plot which in turn used as source of energy and income generator. From this, it is possible to conclude that the over all vegetation coverage in the area is increasing due to the conservation methods applied.



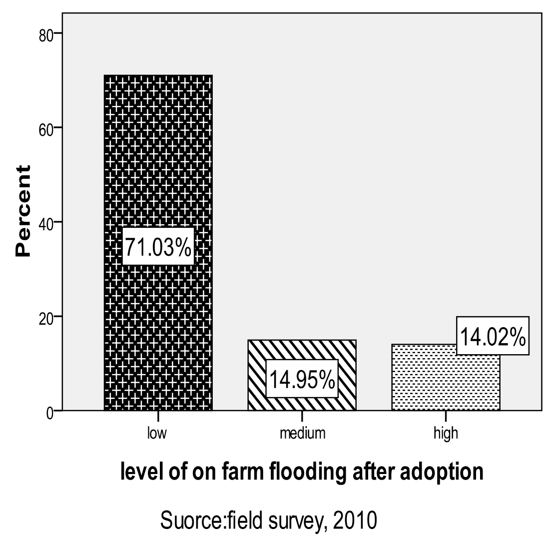


Table 14a: Level of on farm flooding before adoption Table 14b: Level of on farm flooding after adoption

Farmers were asked to compare flooding situation before and after adoption of soil conservation methods. Out of the total respondents 75.7% replied that on farm flooding is high before adoption of soil conservation (Figure 14a). They reasoned that the protection capacity of traditional method of soil conservation in the area is not addressing to control flooding on farm plot. And the level of adaption after adoption is high (71%) (Figure 14b). This is because of the adopted method of soil conservation structures such as water way and cut off drain play significant role in addressing controlling flood on farm lands. Conservation technology can mitigate the consequences of flooding and thus can reduce associated crop damage and topsoil run-off during high-rainfall periods (Shively, 1999). Hence, adopted methods of soil conservation are effective in addressing on farm flooding than that of traditional.

Table 15: The over all condition of adopted methods of soil conservation

Alternatives	Frequency	Percent
Poor	1	.9
Good	20	18.7
Very Good	86	80.4
Total	107	100.0

Source: Field survey, 2010

Although visible benefit from conservation need long period, changes were observed in certain period after project intervention. Table 15 indicates that out of the total sample respondents, 86% stated that the over all conservation effort by GTZ micro project intervention is good. This result shows that farmers who adopt different method of soil conservation through community watershed management increases the resilience of community to shock like drought and flooding in short and long terms.

4.4. Challenges Farmers Faced in Adopting Soil Conservation Techniques

Farmers in a country or region, where natural resource management is not practiced, face a number of problems which make adoption difficult. It is true that new technologies that lead to immediate fast adoption often show obvious advantages resulting in fast acceptance and enthusiasm. Much of the knowledge a farmer has learned and been told that the benefits offered by soil conservation are not obvious in the beginning. In the study area there are many challenges farmers face in adopting method of soil conservation. These problems are of diverse nature, such as intellectual, technical, financial and infrastructural.

Some farmers faced several of these problems, if not all, at the same time to the effect that many farmers adopt soil conservation practices.

Many farmers replied the challenges are mainly severe at the beginning stage of the conservation. This is mainly related to lack of awareness on the benefits of conservation structures and technical constraints related to measurements like field meter readings mainly observable on those who have no formal schooling. Significant number of farmers told that they lack on-site technical assistance before they would proceed with conservation practices.

In relation to this, one farmer stated that*:*

> *"They told us to construct conservation structures through our development team. I did not expect its implementation on my farm which is to small size and found on steep slope and made it too small from before. Then I used to remove the structure at night with my family." However, the development team brought me to the local court and warned me not to remove it again if not they decided to take me to Woreda court. Then I keep quite from removing the structures and the crop production in that year is minimum as I expected. However, in the coming year and after I maintain the structure and grow the same crop where the productivity thoroughly increased year after year.*"

Hence, once the step-wise adoption begins, soil conservation improves its performance over time. The more experience farmers have with soil conservation, the more convinced and positive is their opinion about it. The less practical experience people will have with soil conservation, the more critical and negative is their attitude towards it (Theodor and Kassam 2009). For early adopters, this learning process and experiential knowledge has therefore involved a lot of trial and error until sufficient local experience and knowledge is accumulated to make the adoption easier. Thus, a relatively large variation in the implementation and performance of soil conservation practices in farmers' fields is obvious.

Another constraint mainly comes from less contact with extension workers (DAs). Table 7 also confirms that the farmers frequency contact with development agent is low (about 59.8%) and had contacts only once per month in which development agents are required to perform technical and other needed assistant. According to development agent, this type of gap was due to shortages of DAs in the watershed and this makes difficult to contact all farmers as required. They confirmed that there are no facilities such as motor bicycle and other incentives to effectively perform the activities needed. Hence, in the study area there are lots of challenges in the process of adoption.

As to the maintenance of the constructed structures, Table 16 illustrate that out of the total respondents, 60.7% maintained adopted physical structures when needed and about 39.3% did not maintain adopted method of soil conservation structure due to various reasons.

Table 16: Age of respondents and maintenances of constructed structures Cross tabulation

		Maintaining the constructed structures				Total	
		N o		Yes			
		Frequency	Percent of Total	Frequency	Percent of Total	Frequency	Percent of Total
Age of respondents	≤ 25	0	.0	2	1.9	2	1.9
	26 _ 45	9	8.4	52	48.6	61	57.0
	46 _ 65	28	26.2	11	10.3	39	36.4
	≥ 66	5	4.7	0	.0	5	4.7
Total		42	39.3	65	60.7	107	100.0

Source: Field survey, 2010

Table: 18 shows that out of those who adopted physical structure in their farm plot, 44.4% did not maintain it as it minimized their farm plot size According to them, the construction of *fanya juu* and soil bund takes much land out of production and farmers failed to maintain the structures. This practice is high among farmers who owned less farm plot size and about 26.2% respond that the adopted physical structure require high labor which they cannot afford.

Table 17: Problems related to constructed physical structures

Why do you **not** maintain the physical structures constructed?	Frequency	Percent of total
It decreased my farm plot size	17	40.4
It needs labor which I cant afford	11	26.2
It escalate erosion in my plot	8	19
I don't have hand tool to maintain it(incentives)	5	12
It is no mare useful	1	2.4
Total	42	100

Source: Field survey, 2010

From Table 17, one can conclude that as age of house hold head increases the issue of maintenance of constructed structures almost ceases because they did not afford labor to maintain it. According to Table 18, 19% of the respondents replied that the adopted physical structures increase erosion in their farm plots. The result of field observation confirmed that due to some technical failure some constructed physical structures are not effective in arresting soil erosion and many of them led to flooding on farm plot. This technical failure is resulted due to incomplete construction of drainage channel (water way) which discharge to the nearby stream channels. The rest (12%) replied that they lack incentives such as hand tools which are important to construct physical structures. Thus the availability of equipment, especially hand tools used for digging is expensive at the local market and often is a problem.

Figure 16: Fractured water way around Ya'i Chebo kebele.

In addition to this, the results of field observation depict that live stock in the area are factors in damaging the constructed physical structures on cultivated land. They area is left to graze freely after crops are harvested and collected and animals move throughout the cultivated lands and damage the constructed structures. The physical conservation structures were built mainly by development team available in the village. As to the maintenance of adopted physical structures, some farmers suspect the continual use of it because it needs labor force which any farm house hold cannot afford. Regarding this, one farmer age 64 who resides in Illamu Goromti kebele and had 2 children living in the other town and 5 children living with him and other are attending their primary school suggest that:

> "*Gareen misooma yoo jiraate male gara fulduraaf mala ammayaa kanaan fayyadamuuf shakki keessan jira"* which means *"Unless the development team persists, I doubt to continually use of this conservation methods."*

This clearly depicts that since maintenance of conservation structures need labor force for those farmers who hold small family size or who had less farm labor and aged (old) farmers, the question of sustainability of conservation structures is under question. According to interview with SWC expert of Ambo Woreda regarding maintenance of structure of soil conservation, responsibility was given to individuals for maintaining private holding and for publicly owned area like gullies and degraded areas, grazing lands, forest/shrubs by community agreement individuals or groups transferred the right to develop, use the benefit gained from it.

Table 18: Continuity to use adopted method of soil conservation

Alternatives	Frequency	Percent
No	29	27.1
Yes	78	72.9
Total	107	100.0

Source: Field survey, 2010

The concept of sustainability is very important concept in NARM intervention as the benefit from such projects need long period of time for full conception and accommodation in peoples behavior. Based on field survey, other formal and informal interview results, the sustainability aspect of the project has been summarized as follows. About 72.9 % (table 18) beneficiaries covered in this survey express the commitment to continue the NARM interventions (to make it part of their production system) if incentives would be provided continuously after withdrawal of the project. All the sample respondents, development agents and project informant told that the beneficiaries have been provided incentives in the form of hand tools, seeds, grass strips and tree seedling. Justification given includes by one woman house hold head as follow:

> **"***Since I got many benefits from the overall conservation effort even if there is no incentive provided by local government and other concerned bodies, I will make the conservation as my production system."*

Farmers were asked about the means how would they continue to undertake conservation measures. They respond that they will try to continue to use the experience gained, if technical and material assistance will be provided and development team persists. In addition to these self initiated adoption and autonomous diffusion of technologies is the most important indicator to its relevance, effectiveness and likelihood of sustained utilization. For the SUN introduced measures, the researcher observed that some of the technologies have been diffused to communities outside of the SUN intervention areas without any direct support from the program. The commonly replicated technologies include Soil Conservation measures on farmland (soil bunds, planting of seedlings).

The rest 27.1% (table 18) replied they doubt their continual use of these adopted methods of soil conservation. They replied that it is important for provision of tools and implements, technical assistance and additional training, strengthening their group (i.e. Development team). The majority farmers complain that tools that have been provided to them now become non functional and shortage of tools hinder their effort, but they frequently cannot afford to purchase these items which are scarcely available in the market and expensive.

During key informant interview, issues related with sustainability of both on farm and off farm conservation activities were raised. Farmers were also asked to suggest on what would be the best way to sustain the project intervention. As far as conservation effort on off farm is concerned, communities who reside near these communal lands (now un available), protection against them were done by community selected farmers who will protect it from external intervention and gave the right to use benefits gained after regeneration like using grass, and others from it.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary and Conclusions

Soil erosion is a threat to the economic development of Ethiopia as it affects the agricultural sector of the country significantly. At the face of increased dependency on the agricultural sector for economic development, sustained use of the land resource has become very important. The study area is characterized by steep and undulating terrain and susceptible to soil erosion. The area also receives heavy rain, which is concentrated in few months of the year. Besides, the economy of society is heavily dependent on agricultural mainly on production of crops requiring fine tilled soil seed beds. This plainly justifies the need for effective soil and water conservation interventions. Through the financial and technical support of GTZ and government, a range of conservation measures were introduced with the objective of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food crop production.

Majority of the conservation measures have been applied on cultivated fields and all of them are physical and biological conservation measures. In this study, the researcher tried to see factors influencing farmers in the adoption of soil conservation practices and also tried to identify the benefits and problems associated with soil conservation activities. The major findings of the study are summarized as here under.

- Farmers who perceived introduced soil conservation structures to be more effective in controlling soil erosion and ensuring sustainability of yield make decision to adopt modern conservation methods.

This implies if farmers perceive traditional measures they use to be less effective in maintaining productive capacity of land, they seek and employ measures that enhance productive capacity of land.

- The study shows that majority farmers in the watershed adopted soil bund, *fanya juu*, cut off drain and water way among the physical structures and grass strips and revegetation from biological conservation methods applied in their farm plot.
- The study also found factors such as slope of the area, training, and contact with extension workers, tenure status, age, size of house hold and farm size influenced farmers to adopt these methods. This could be due to the fact that farmers whose plot is found on steep slopes have attended training and got information that are useful to make decision to adopt conservation structures.
- The study shows that adopted physical soil conservation structures are effective in arresting the level of erosion and flooding on farm plot.
- The study also found that adopted soil conservation measures contributed in increasing farm productivity through retaining moisture content of soil and are effective in restoration of vegetation in the area.
- As with any agricultural production system, soil conservation also requires certain exogenous inputs to achieve more production levels. Many farmers in the study area did not use credit scheme. This is mainly because much awareness is not done regarding the problem of the present study area or farmer's perception in borrowing from government is misleading.

- Older farmers tend not to retain conservation structures in the original state as age influences farmers' decision to retain conservation structures negatively and significantly. This is because older farmers lack the required supply of labor to maintain and retain conservation structures in the original state as physical conservation measures are very labor demanding.
- The other problems identified include conservation structures take the scarce cultivable land out of cultivation (reduce size of land), lack of hand tools required to maintain the structures, labor constraint and some technical failures. In addition to these, farmers who perceive the structures reduce farm plot made decision not to maintain conservation structures or even remove structures completely.

5.2. Recommendations

The adoption of newly introduced soil conservation in the study area at present signify that addressing multi dimensional socio economic and institutional constraints of farmers. Adoption of soil conservation methods does not happened spontaneously in the area. There are good reasons for individual farmers not to adopt soil conservation methods in her/his specific farm situation. The origin of the hurdles ranges from intellectual, financial, biophysical and technical, infrastructural issues. Knowing the respective bottlenecks and problems allows developing strategies to overcome the problem of soil conservation. Thus, based on the findings, the following recommendations are important and need to be considered to enjoy more benefits by addressing the constraints farmers meet in adoption of soil conservation methods.

- ❖ The overall strategy for both on farm and off farm conservation in the study area is appreciable and also the project should not try to change such successful beginnings. However, to ensure the sustainability of project intervention there should be continuous follow up of local government to check on farm maintenance on constructed structures and strength the development team in their respective kebeles. Technical and management capacity of the community watershed development team should be strengthen through intensive technical on the job training of community participant. In addition to this, closer follow up by Woreda watershed team is necessary to further identify the problem farmers met and mitigate them.

- ❖ The study found that factors such as slope of the area, training, and contact with extension workers, tenure status, age, size of house hold and farm size influenced farmers to adopt these methods. Therefore, it is reasonable to recommend that adequate consideration of these variables may greatly contribute to increase the sustainable use and widespread adoption of introduced conservation structures in the study area and elsewhere in the country which might have a more or less similar physical set up.
- ❖ The study found that cultivation expanded to all corners of the study area including to steeper and marginal parts. It is advisable to introduce appropriate land use planning in the area by giving due consideration to farmers preference.
- ❖ Farmer's knowledge gained from training had positive impact on continual of adoption of conservation methods. However, frequency of contact between the farmers and the extension agents was quite low; seem to have less influence on adoption. Hence, it is recommendable that extension agents have to be provided with incentives and adequate trainings that enable them fulfill their responsibilities properly. Assigning more DAs with different specialization in each Kebele may resolve the shortfall.
- ❖ Small land size influenced farmers' decision to maintain conservation structures. These farmers have to be provided with support to undertake and maintain the conservation structures. This necessitates intensification of agricultural production through the provision of appropriate support services. To realize success in this regard, agricultural research, extension and provision of farm inputs (improved seed etc) have to be combined with soil conservation activities. As hand tools are found to

be a major resource constraints, better supply of such measures at implementing stage as well as ensuring access are also highly recommendable.

- It was also found that in the absence of the current incentive, some farmers will not be interested to maintain conservation structures in the cultivated fields. Thus, sustainable adoption and widespread use of conservation seems requiring more than installation of structures. Hence, it is crucial to support farmers with incentives which will help them to continual use of adopted method of soil conservation.
- Action is also needed to increase farmers' awareness of the importance of conservation structures through demonstration and training. This should be an integral part of soil conservation initiatives and helps to foster positive perception and shapes the attitude of framers towards soil conservation efforts.
- The other problems identified include conservation structures; take the scarce cultivable land out of cultivation some technical failure and lack of hand tools made maintenance of conservation structures difficult. Promotion of agronomic methods can help in this regard. Also, examination of the problems and improving the effectiveness of the existing one through research will assist in bringing down the scale of the problems mentioned and ensure the widespread use of them. It is also recommended to integrate the promotion of yield enhancing inputs together with conservation activities. Technologies that not only reduce soil erosion but also substantially improve yield are needed.
- To sum up, given the significance of agriculture and exploitation of natural resources in the study area and other places which have almost similar spatial set up, the problem of soil erosion has to be given due emphasis and taken seriously and

genuinely. To this end, it is important to give adequate consideration of those points discussed above. The aspects emphasized and the recommendations forwarded could contribute substantially towards the sustainability of soil conservation measures.

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APPENDIX: A

RESULT OF BI VARIATE CORRELATION BETWEEN VARIABLES

	Soil bund		
	Pearson correlation	Sig. (2-tailed)	N
Age	.007	.945	107
Sex of respondents	.265**	.006	107
Size of land	.052	.593	107
Size of house	.437**	.000	107
Contact with extension workers	.421**	.000	107
Visiting demonstration	.347**	.000	107
Farmers training	.599**	.000	107
Farm plot slope	.728**	.000	107
Educational level	.180	.064	107
Tenure type	.190	.050	107
Soil bund	1		107
**. Correlation is significant at the 0.01 level (2-tailed).			

	Fanya juu		
	Pearson correlation	Sig. (2-tailed)	N
Age	.025	.796	107
Sex of respondents	.169	.083	107
Size of land	-.043	.660	107
Size of house	.368**	.000	107
Contact with extension workers	.482**	.000	107
Visiting demonstration	.599**	.000	107
Farmers training	.576**	.000	107
Farm plot slope	.728**	.000	107
Educational level	.019	.845	107
Tenure type	.162	.096	107
Fanya juu	1		107
**. Correlation is significant at the 0.01 level (2-tailed).			

	Cut off drain		
	Pearson correlation	Sig. (2-tailed)	N
Age	1		107
Sex of respondents	.096	.324	107
Size of land	.060	.542	107
Size of house	.092	.346	107
Contact with extension workers	.252**	.009	107
Visiting demonstration	.362**	.000	107
Farmers training	.114	.244	107
Farm plot slope	.415**	.000	107
Educational level	.052	.595	107
Tenure type	.092	.344	107
Cut off drain	.086	.377	107
**. Correlation is significant at the 0.01 level (2-tailed).			

	Water way		
	Pearson Correlation	Sig. (2-tailed)	N
Age	.063	.520	107
Size of land	.060	.542	107
Sex of respondents	.096	.324	107
Size of house hold	.148	.129	107
Contact with extension workers	.252**	.009	107
Visiting demonstrations	.362**	.000	107
Farmers training	.114	.244	107
Farm plot slope	.415**	.000	107
Educational level	.089	.364	107
Tenure type	.092	.344	107
Water way	1		107
**. Correlation is significant at the 0.01 level (2-tailed)			

	Grass strip		
	Pearson Correlation	Sig. (2-tailed)	N
Age	.093	.342	107
Sex of respondents	.050	.610	107
Size of land	.005	.959	107
Size of house	.333**	.000	107
Contact with extension workers	.241*	.013	107
Visiting demonstration	.261**	.007	107
Farmers training	.468**	.000	107
Farm plot slope	.565**	.000	107
Educational level	.019	.842	107
Tenure type	.155	.110	107
Grass strip	1		107
**. Correlation is significant at the 0.01 level (2-tailed).			
*. Correlation is significant at the 0.05 level (2-tailed).			

APPENDIX: B

Percentage distribution of adopted techniques of soil conservation by size of household

Adopted method of soil conservation		Size of household		Total
		≤ 6	7+	
Soil bund	Frequency	25	53	78
	% within SHH	50.0	93.0	
	% of total	23.4	49.5	72.9
Fanya juu	Frequency	37	56	93
	% within SHH	74.0	98.2	
	% of total	34.6	52.3	86.9
Cut off drain	Frequency	47	55	102
	% within SHH	94.0	96.5	
	% of total	43.9	51.4	95.3
Water way	Frequency	25	41	66
	% within SHH	50.0	71.9	
	% of total	23.4	38.3	61.7
Grass strip	Frequency	33	50	83
	% within SHH	66.0	87.7	
	% of total	30.8	46.7	77.6
Compost	Frequency	18	22	40
	% within SHH	36.0	38.6	
	% of total	16.8	20.6	37.4
Live fence	Frequency	21	22	43
	% within SHH	42.0	38.6	
	% of total	19.6	20.6	40.2
Revegetation	Frequency	22	31	53
	% within SHH	44.0	54.4	
	% of total	20.6	29.0	49.5
Area enclosure	Frequency	21	23	44
	% within SHH	42.0	40.4	
	% of total	19.6	21.5	41.1
Agro forestry	Frequency	11	8	19
	% within SHH	22.0	14.0	
	% of total	10.3	7.5	17.8
Total	Frequency	50	57	107
	% of total	46.7	53.3	100.0

Percentages and totals are based on respondents.

Percentage age distribution of adopted techniques of soil conservation by sex

Adopted methods of soil conservation		Sex of respondents		Total
		Male	Female	
Soil bund	Frequency	67	11	78
	% within sex	74.4	64.7	
	% of total	62.6	10.3	72.9
Fanya juu	Frequency	69	14	83
	% within sex	76.7	82.4	
	% of total	64.5	13.1	77.6
Water way	Frequency	52	14	66
	% within sex	57.8	82.4	
	% of total	48.6	13.1	61.7
Cut off drain	Frequency	86	17	103
	% within sex	95.6	100.0	
	% of total	80.4	15.9	96.3
Grass strip	Frequency	69	14	83
	% within sex	76.7	82.4	
	% of total	64.5	13.1	77.6
Compost	Frequency	35	5	40
	% within sex	38.9	29.4	
	% of total	32.7	4.7	37.4
Live fence	Frequency	34	9	43
	% within sex	37.8	52.9	
	% of total	31.8	8.4	40.2
Revegetation	Frequency	45	8	53
	% within sex	50.0	47.1	
	% of total	42.1	7.5	49.5
Area enclosure	Frequency	36	8	44
	% within sex	40.0	47.1	
	% of total	33.6	7.5	41.1
Agro forestry	Frequency	9	10	19
	% within sex	10.0	58.8	
	% of total	8.4	9.3	17.8
Total	Frequency	90	17	107
	% of total	84.1	15.9	100.0

Percentages and totals are based on respondents.

Percentage distribution of adopted techniques of soil conservation by Educational level

Adopted method of soil conservation		Educational level		Total
		Have no schooling	Have schooling	
Soil bund	Frequency	50	28	78
	% within Edu level	67.6	84.8	
	% of total	46.7	26.2	72.9
Fanya juu	Frequency	64	29	93
	% within Edu level	86.5	87.9	
	% of total	59.8	27.1	86.9
Cut off drain	Frequency	71	31	102
	% within Edu level	95.9	93.9	
	% of total	66.4	29.0	95.3
Water way	Frequency	47	19	66
	% within Edu level	63.5	57.6	
	% of total	43.9	17.8	61.7
Grass strip	Frequency	57	26	83
	% within Edu level	77.0	78.8	
	% of total	53.3	24.3	77.6
Compost	Frequency	21	19	40
	% within Edu level	28.4	57.6	
	% of total	19.6	17.8	37.4
Live fence	Frequency	23	20	43
	% within Edu level	31.1	60.6	
	% of total	21.5	18.7	40.2
Revegetation	Frequency	35	18	53
	% within Edu level	47.3	54.5	
	% of total	32.7	16.8	49.5
Area enclosure	Frequency	28	16	44
	% within Edu level	37.8	48.5	
	% of total	26.2	15.0	41.1
Agro forestry	Frequency	4	15	19
	% within Edu level	5.4	45.5	
	% of total	3.7	14.0	17.8
Total	Frequency	74	33	107
	% of total	69.2	30.8	100.0

Percentage and totals are based on respondents.

Percentage distribution of adopted techniques of soil conservation by size of land

Adopted method of soil conservation		Size of land						Total
		< 0.5 Hat	0.5 -1.0 Hat	1.1 -1.5 Hat	1.6 -2.0 Hat	2.1 -2.5 Hat	> 2.5 Hat	
Soil bund	Frequency	4	17	37	10	5	5	78
	% within land size	100.0	65.4	75.5	58.8	83.3	100.0	
	% of total	3.7	15.9	34.6	9.3	4.7	4.7	72.9
Fanya juu	Frequency	4	22	45	12	5	5	93
	% within land size	100.0	84.6	91.8	70.6	83.3	100.0	
	% of total	3.7	20.6	42.1	11.2	4.7	4.7	86.9
Cut off drain	Frequency	4	25	46	16	6	5	102
	% within land size	100.0	96.2	93.9	94.1	100.0	100.0	
	% of total	3.7	23.4	43.0	15.0	5.6	4.7	95.3
Water way	Frequency	3	17	29	9	4	4	66
	% within land size	75.0	65.4	59.2	52.9	66.7	80.0	
	% of total	2.8	15.9	27.1	8.4	3.7	3.7	61.7
Grass strip	Frequency	4	19	40	10	5	5	83
	% within land size	100.0	73.1	81.6%	58.8	83.3	100.0	
	% of total	3.7	17.8	37.4	9.3	4.7	4.7	77.6
Compost	Frequency	1	5	22	8	2	2	40
	% within land size	25.0	19.2	44.9	47.1	33.3	40.0	
	% of total	.9	4.7	20.6	7.5	1.9	1.9	37.4
Live fence	Frequency	2	9	19	9	2	2	43
	% within land size	50.0	34.6	38.8	52.9	33.3	40.0	
	% of total	1.9	8.4	17.8	8.4	1.9	1.9	40.2
Revegetation	Frequency	1	11	24	9	6	2	53
	% within land size	25.0	42.3	49.0	52.9	100.0	40.0	
	% of total	.9	10.3	22.4	8.4	5.6	1.9	49.5
Area enclosure	Frequency	2	10	21	7	3	1	44
	% within land size	50.0	38.5	42.9	41.2	50.0	20.0	
	% of total	1.9	9.3	19.6	6.5	2.8	.9	41.1
Agro forestry	Frequency	1	2	5	7	3	1	19
	% within land size	25.0	7.7	10.2	41.2	50.0	20.0	
	% of total	.9	1.9	4.7	6.5	2.8	.9	17.8
Total	Frequency	4	26	49	17	6	5	107
	% of total	3.7	24.3	45.8	15.9	5.6	4.7	100.0

Percentage and totals are based on respondents.

Percentage distribution of adopted techniques of soil conservation by age

Adopted method of soil conservation		Age of respondents		Total
		≤ 44	45+	
Soil bund	Frequency	41	37	78
	% within Age	70.7	75.5	
	% of total	38.3	34.6	72.9
Fanya juu	Frequency	50	43	93
	% within Age	86.2	87.8	
	% of total	46.7	40.2	86.9
Cut off drain	Frequency	55	47	102
	% within Age	94.8	95.9	
	% of total	51.4	43.9	95.3
Water way	Frequency	33	33	66
	% within Age	56.9	67.3	
	% of total	30.8	30.8	61.7
Grass strip	Frequency	43	40	83
	% within Age	74.1	81.6	
	% of total	40.2	37.4	77.6
Compost	Frequency	20	20	40
	% within Age	34.5	40.8	
	% of total	18.7	18.7	37.4
Live fence	Frequency	25	18	43
	% within Age	43.1	36.7	
	% of total	23.4	16.8	40.2
Revegetation	Frequency	24	29	53
	% within Age	41.4	59.2	
	% of total	22.4	27.1	49.5
Area enclosure	Frequency	26	18	44
	% within Age	44.8	36.7	
	% of total	24.3	16.8	41.1
Agro forestry	Frequency	8	11	19
	% within Age	13.8	22.4	
	% of total	7.5	10.3	17.8
Total	Frequency	58	49	107
	% of total	54.2	45.8	100.0

Percentage and totals are based on respondents.

APPENDIX: C

House hold Questionnaire

Dear respondents,

This questionnaire is designed to collect data that are intended to investigate benefits and challenges of adopting method of soil conservation in Ambo Woreda: Case of Goromti watershed. To achieve this purpose your response to the questions presented below has a great value. Thus, you are kindly requested to read and respond the clearly and genuinely.

- **Mark (√) against the provided question below.**

Name of Peasant Association ______________________ Date ________________

Name of the Watershed ____________________

Name of the Agro ecological Zone _________________Personal Code No__________

I. Personal Data

1. Age ________
2. Sex: A. Male [ ] B. Female [ ]
3. Educational level A. No schooling [ ] B. read and write [ ]
   C. Elementary [ ] D. Secondary School [ ]
   D. Higher education [ ]
4. Size of your house hold____________

II. Farmers Perception Towards Soil Erosion and their Response

1. Did you perceive the presence of soil erosion? A. Yes [ ] B. No [ ]
2. If your answer No 1 is yes what do you think is the major cause of soil erosion in your locality? Sequence it according to the major cause of soil erosion?
   A. Rain fall [ ]
   B. Cultivation on steep slope [ ]
   C. Intensive cultivation (less or absence fallow) [ ]
   D. Deforestation. [ ]
   E. Overgrazing [ ]
   F. Absence of conservation practices[ ]
   G. Absence of crop rotation [ ]
   H. Absent or low inorganic fertilizer application [ ]
   I. Low or absence of organic fertilizer application [ ]

J. If others Please specify_________________________________

3. What do you think the consequences of soil erosion (rank)?

   A. Land productivity (yield) decrease [ ]

   B. Change in type of crops grown[ ]

   C. Land preparation becomes difficult

   D. Reduced farm size [ ]

   E. Poverty [ ]

   F. Land become out of cultivation [ ]

   G. Migration [ ]

   H. Others, please specify __________

4. What measure do you take when the productivity of your plot declines?

   A. Change to other plot [ ]

   B. Improve the fertility [ ] C. Both [ ]

5. If you change to other plot, what kind of plot do you opt for?

   A. Clear forest [ ] B. Fallow land [ ] C. Both [ ]

6. How do you keep your fertility of soil in your field?

   A. By using manure [ ] E. Gay system (burning) [ ]

   B. Crop rotation [ ] F. By compost [ ]

   C. Fallowing [ ] G. Fertilizer [ ]

   D. If other please mention________________

7. Did you or your parents put any traditional soil conservation structure in the plot of land? A. Yes [ ] B. No [ ] C. No Idea [ ]

8. If your answer to question No – 7 is yes, what were such methods

   A. ______________________________

   B. ___________________________

9. Is your farm plot treated with new soil conservation measures currently?

   A. Yes [ ] B. No [ ]

10. If question No 9. Is yes, what are the newly method of soil conservation in your area? Thick as you can

A. Physical conservation structures

a) Stone and stone-faced terracing[ ]

b) *Fanya juu* [ ]

c) *S*oil bund [ ]

d) Cut-off drains [ ]

h) Waterway [ ]

i) Other____

B. Biological conservation methods

a) Compost in main plot [ ]

b) Bund stabilization (on, below and above bund plantation) [ ]

c) Live fence around homesteads and farm lands[ ]

d) Gulley stabilization or re-vegetation[ ]

e) Area enclosure and enrichment plantation[ ]

f) Agro forestry including trees on farmlands[ ]

g) Other ____

11. If yes when did it starts its treatment?

A.1-3 years [ ] B. 4-6 years [ ] C. 7 years and above. [ ]

12. Who constructed the structures?

A. Community participation [ ]

B. Family (hired) labour [ ]

C. Labour exchange [ ]

D. If other please specify________________________

13. What is the major occupation of your house hold?

A. Crop farming only [ ]

B. Livestock only [ ]

C. Mixed farming [ ]

D. Other/Mention________________________

14. What are the major problems of your farm plot? Sequence it according to their severity

A. Flooding [ ] D. Insect [ ]

B. Erosion [ ] E. Hail storm [ ]

C. Rodents [ ] F. Shortage of rain [ ]

D. Animal trampling [ ] G. If other please specify________________

15. What type of crops is grown in your farm plot? __________________

III. Major issue: - Livestock resources, land holding, access to credit, social infrastructure and income.

16. Do you have live stock? A. Yes [ ] B. No [ ]

17. How many live stocks do you own? Fill the following table below

Type of livestock	Quantity in number
Cow	
Oxen	
Calf	
Goat	
Sheep	
Equines	
Others	

18. What type of fuel do you use? Thick as they can.

A. Crop residue [ ] C. Forest wood [ ]

B. Animal dung [ ] D. Other ______

19. What Type of land-use do you own?

A. Cultivated land [ ] D. Fallow land [ ]

B. Grazing land [ ] E. Homestead area [ ]

C. Wood land [ ] F. If other please specify____________

20. Do you have enough land for cultivation? A. Yes [ ] B. No [ ]

21. What is the size of your farm land? In *timad*_____________

22. Tenure type A. State/own [ ] B. Rent-in [ ] C. Sharecrop-in [ ]

23. Is there any institution that provides credit to you? A. Yes [ ] B. No [ ]

24. If yes what is the source credit? A. Government [ ] B. Local trader's [ ]

C. Local credit institutions [ ] D. Micro Financial Institutions (MFIs). [ ]

E. If other please specify___________

25. Do you take any credit from the institution? A. Yes [ ] B. No [ ]

26. What role did access to credit played in conservation of soil? ____

27. For which of the following do you have access in your locality?

Social services	Available	Not available
Primary school		
Road		
Clinic		
Veterinary service		
Market		
Water		

28. If other please mention it___________________________

Major issue: - Participation and access to extension services

29. How are you participating in soil conservation today?

A.voluntarly [ ] B. Forced to participate [ ] C. Not involved [ ]

30. Did you have any contact with extension or development agents' workers?

A. Yes [ ] B. No [ ]

31. How often have you obtained extension advice on the problem and solution of land degradation?

A. Once per month [ ] C. Three times per month [ ]

B. Twice per month [ ] D. Once per three month [ ]

E. If any others, please specify __________

32. Have you taken any farmers' training course? A. Yes [ ] B. No [ ]

33. If yes what type of training did you take? ______________________

34. Did you visit demonstration or farm experiment regarding how to conserve soil?

A. Yes [ ] B. No [ ]

35. Who provided such training and Demonstrations?

A. Woreda office of agriculture [ ]

B. NGOs [ ] C. If other please specify[ ]

36. Was such training and demonstration is useful in conservation soil?

A. Yes [ ] B. No [ ]

37. If yes how do you express its usefulness_____________?

38. Have you acquired enough technical knowledge which motivates you to continually use method of soil conservation? A. Yes [ ] B. No [ ]

39. Did you believe that investment in the soil conservation practices is profitable in the long run? A. Yes [ ] B. No [ ]

40. Are there any improved crop varieties which are suitable to soil type in your locality?

A. Yes [ ] B. No [ ]

41. What do you say regarding the supply of crop varieties which tolerate soil erosion?

A. Sufficient and expensive [ ] B. Sufficient [ ]

C. Insufficient [ ] D. If other please specify_______________

42. How do you see the adopted method of soil conservation?

A. Poor [ ] B. Good [ ]

C. V-good [ ] D. Best [ ]

IV. Major issue: - Benefits and constraints of adopting of method of soil conservation.

43. How do you see the level of erosion **before** adoption of soil conservation?

A. No erosion [ ] B. Low erosion [ ]

C. Medium erosion[ ] D. Severe erosion [ ]

44. How do you relate the level of erosion **after** adoption of soil conservation?

A. No relation [ ] B. Low erosion (decreasing) [ ]

C. Medium erosion (increasing) [ ] D. Severe erosion [ ]

45. What is your plot level crop productivity **before** adoption of soil conservation?

A. Low [ ] B. Medium [ ] C. High [ ]

46. How do you relate your crop productivity **after** adoption of soil consideration?

A. Low (no relation) [ ] B. Medium (decreasing) [ ]

C. High (increasing) [ ] D. Constant [ ]

47. What is the over all coverage of vegetations **before** adoption of soil conservation?

A. Low coverage [ ] C. High coverage[ ]

B. Medium coverage [ ]

48. What is the extent of vegetation cover **after** adoption of soil conservation?

A. Low coverage [ ]   C. High coverage [ ]

B. Medium coverage [ ]   D. Constant [ ]

49. What is the level of on farm flooding **before** adoption of soil conservation?

A. Low flooding [ ]   C. High flooding[ ]

B. B. Medium flooding [ ]

50. What is the level of on farm flooding **after** adoption of soil conservation?

A. Low (decreasing) [ ]   B. Medium [ ]   C. High (increasing) [ ]

51. What is the level of soil moisture content **before** adoption of soil conservation?

A. Low [ ]   B. Medium [ ]   C. High [ ]

52. What is the level of soil moisture content **after** adoption of soil conservation?

A. Low [ ]   B. Medium [ ]   C. High [ ]

53. If there are any other benefits you gain, mention it please? _____________

____

54. What are the major constraints you meet in adoption of method of soil conservation? Put a √ mark as follows.

Constraints of adopted method of soil conservation Indicators	**Remark**	
	Yes	**No**
A. Constructing physical conservation		
B. Breed place of rodents		
C. Lack of incentives		
D. Labor shortage Take high labor force		
E. Decrease the size of the plots		
F. Problem related to drainage		
G. Difficult to plough and turn the oxen		

55. Are there any other constraints you met because of adopted method of soil conservation? If yes please mention?_________________________________

56. In your opinion what should be done to mitigate the aforementioned constraints?

Thank you!

APPENDIX: D

Interview protocol for NARM experts in Ambo Woreda.

Interviewer ________ Date of interview________________

Interviewee_____________________________

Personal information

1. Name---------------------------- -----------------------------------
2. Position --------------------------------
3. Educational back ground I. Qualification------------------------
4. Work experience ---

I. Major issue: the overall activities of the project

1. When the project was started its activities? What are the main objectives of the project under work?
2. What have done in the overall natural resource management, Soil conservation in particular?
3. What are the traditional methods of soil conservation in the area? How do you rate farmer's traditional natural resource management in general and soil conservation in particular?
4. What is the Extent of community participation in planning designing, implementing monitoring and Executing soil conservation decision? How willing are the village community members to commit resource? How task are assigned to fulfill the responsibility?
5. What are the newly introduced methods of soil conservation? Among newly introduced method of soil conservation, what is the type of soil conservation farmers adopted well? And why?
6. What is the criterion used to select farmers to adopt method of soil conservation? How do you see the perception of farmers in adopting method of soil conservation and soil erosion?
7. Are there any types of package that you have introduced farmers to gain additional source of income?

8. How do you evaluate the degree of empowerment of community towards making decision in regarding to soil conservation?
9. Do you belief farm size, land tenure and labor shortage affect adoption of soil conservation? If yes how?
10. Are there any challenges that farmers meet in adopting method of soil conservation? If yes what are the challenges?
11. Are there any benefits that farmers gained as a result of adopting method of soil conservation? If yes what are benefits?
12. What do you suggest for farmers who meet challenges as a result of adopting method of soil conservation? What is expected
    A. From government
    B. From NGOs
    C. From community
    D. Other concerned bodies.
13. Do you belief farmers will continue to maintain and undertake soil conservation after the withdrawal of the project?
14. If anything you want to add in connection of our discussion?

APPENDIX: E

Interview protocol for key informant

Interview on the over all condition of adopted methods of soil conservation

1. How do you evaluate the socio economic condition of the village in terms of the level of education, income, health and other?
2. What experience does the village community have in the past in terms of collectively managing natural resource in general and soil conservation in particular?
3. When was soil conservation structures introduced in these villages? What are adopted methods of soil conservation?
4. What is your free contribution to wards conserving natural resource in general and soil conservation in particular? How do you see community participation in conserving soil around your community?
5. How do you see the extension workers service in the village? Its adequacy and sufficiency? How do you evaluate the visit of development agents in giving advice especially regarding soil conservation?
6. How do you evaluate the degree of empowerment of community to wards making decision in regarding to soil conservation? How willing are the community members to commit resource?
7. Is there any benefit that the community gained because of adopted method of soil conservation? If yes please mention with regard to soil erosion, productivity, vegetation cover, soil moisture content, on farm flooding and others.
8. What are challenges encountered as a result of these adopted methods of soil conservation?
9. What things (modifications) should be applied to tackle these constraints?
10. ***Any thing would you like to mention in relation to our discussion?***

APPENDIX: F

Observation Check List

Date of observation_____________ Place of observation (watershed) ______________

Peasant association ____________ House hold code____________

1. The overall condition of soil conservation on farm as well as off farm (conservation history)
   1.1. Physical conservation structures quality and quantity
      - Stone and stone-faced terracing, *Fanya juu and S*oil bund, Cut-off drains and Waterways, Check dams (stone, concrete, gabion, brush, Others
   1.2. Biological conservation structures quality and quantity
      - Presence of compost in main plot, Bund stabilization (on, below and above bund plantation) and Grass strips, others, Live fence around homesteads, farm lands and Gulley stabilization or re-vegetation,
      - Area enclosure and enrichment plantation ,Nursery development, agro forestry including trees on farmlands Small woodlots (communal and individual Others
2. Availability of adopted method of soil conservation and types
3. Livelihood condition of the area
4. House hold initiation in soil conservation
5. The coverage of adopted method of soil conservation in relation to total size of land holding
6. The status of treated plot with adopted method of soil conservation?
   - Opportunities (benefits)
   - Challenges
7. Crop productivity on the farm plot and crop stored around home stead
8. Erosion extent on farm plot as well as off farm plot Degree of erosion problem on the plot
9. Soil types, structure and Slope of the area
10. Vegetation types and major crops grown in the area
11. Grazing status and deforestation.
12. Type of soil conservation measure
13. Status of soil and water conservation structure at the time of interview

Declaration

I undersigned declare that this thesis which entitled “Benefits and Challenges of Adopting Soil Conservation Techniques in Goromti Watershed, Central Ethiopia” is my original work that has not been presented for any degree to any university and that all relevant sources used in the thesis have been due acknowledged.

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