FACTORS AFFECTING THE ADOPTION OF SOIL AND WATER CONSERVATION PRACTICES IN NORTH EASTERN ETHIOPIA.

A CASE STUDY OF MEKET WOREDA, ANRS.

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MASTER OF ART (M.A) THESIS

By

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ADDIS ABABA, ETHIOPIA

JULY, 2009

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES (CDS)

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A Thesis submitted to the School of Graduates Studies of Addis Ababa University In Partial Fulfillment of the Requirements for the Degree of Master of Arts in Development Studies specialized in Environment and Development

M.A THESIS

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Title

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DEDICATION

For those people who fall in love and made sacrifications for it.

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ANRS............................ Amhara National Regional State
CSA...............................Central Statistical Authority
DA................................Development Agent
EHRS.............................Ethiopian Highland Reclamation Study
ETB...............................Ethiopian Birr
FAO...............................Food and Agricultural Organization
FDRE.............................Federal Democratic Republic of Ethiopia
FFW...............................Food for Work
FGD...............................Focus Group Discussion
FTC...............................Farmers Training Center
Ha.................................Hectare
HH................................Household Head
GDP...............................Gross Domestic Product
Km.................................Kilo meter
m.a.s.l............................Meter above sea level
MWIO............................Meket Woreda Information Office
NGO...............................Non Governmental Organization
SCRP.............................Soil Conservation Research Project
SPSS..............................Statistical Package for Social Science
SWC...............................Soil and Water Conservation
TLU...............................Tropical Livestock Unit
USAID...........................United State Agency for International Development
WARDO........................Woreda Agricultural and Rural Development Office
WFP..............................World Food Program
WOCAT.........................World Overview of Conservation Approach and Technology

ABSTRACT

In the past, various soil and water conservation practices were introduced and implemented in Ethiopia. Still, those technologies failed to get acceptance of the land users because of their limitations and constraints. Thus, identification of constraints in relation to the adoption of soil and water conservation practices is of paramount importance. The study was undertaken in Meket Woreda of North Eastern Ethiopia, ANRS. The data were collected from 105 farmers residing in 4 Kebeles that are randomly selected from 35 rural Kebeles where soil and water technologies have been introduced and widely implemented. Both qualitative and quantitative data were used to have reliable information. The basic data used for this study were collected from sample households, focus group participants and key informants through structured questionnaire and semi-structured checklists. Descriptive statistics and binary logistic model were employed to assess and identify the factors that determine adoption of soil and water conservation practices. Both indigenous and improved SWC measures are practicing in the study area. About 64.8% of the sampled farmers were adopters and 35.2% were non-adopters of SWC measures. Demographic, socio-economic and institutional factors influence the investment of households commit to soil and water conservation measures. The result of the model shows that the explanatory variables: farmers' level of perception on soil erosion, farmers experience in farming and extension service given by development agents increases the likelihood of adoption of soil and water conservation practices measures by the farmers. On the other hand, involvement in off-farm activities has a negative and significant influence on the adoption of soil and water conservation activities in the study area. In order to improve SWC practices; policy makers, extension experts and development agents should give due attention for those significant variables that determine farmers' adoption of SWC measures.

1. INTRODUCTION

1.1. Background of the study

Ethiopia is endowed with favorable environment that support various life forms including agricultural crops. Agriculture is the main economic activity for the majority of the population and its contribution to the national economy is also very significant. According to FDRE (1997), it accounts for about 85 percent of the GDP, 85 percent of the exports and 80 percent of the total employment. About 90 percent of the population lives by cultivating the land and more than 50 percent of the export earnings derived from the sale of the farm produce (Shiferaw and Holden, 2004).

However, agricultural practices in Ethiopia are characterized by low productivity and different explanations are forwarded to this daunting performance of the sector in the country. Inappropriate agricultural policies, inadequate use of technologies and poorly structured markets for agricultural inputs and outputs have contributed enormously to the poor performance of agriculture (Abera, 2003). Natural resource degradation particularly soil degradation in the form of nutrient depletion is another important cause for the decline in the country's agricultural production (Bekele and Holden, 1998).

In Ethiopia, soil degradation has reached at a severe stage. The average annual rate of soil loss in Ethiopia is estimated to be 12 tons/hectare/year, and it can be even higher on steep slopes with soil loss rates greater than 300 tons/hectare/year where vegetation cover is scant (USAID, 2000).

Soil erosion is a process of losing soil particles and transporting it by water or wind until the point at which the transportation capacity is reduced and sedimentation takes place. Often enhanced by human activities, soil erosion is a multidimensional problem in which not only biophysical factors, but also social, economic, cultural and political factors are influential. As a consequence, no simple explanation for the causes and effects of soil erosion can be given. Instead, an area-specific study must be done to ascertain the factors influencing the extent of soil erosion and the adoption and use of conservation measures as these might differ spatially (Selamyihun, 2004).

Soil and water conservation measures are apparently very important to improve land productivity and environmental health. In Ethiopia, efforts towards soil and water conservation measures were started since the mid 1970s and 80s (Wogayehu and Drake, 2001; Bekele and Holden, 1998). Since then, different soil and water conservation technologies with a varied approach has been underway. The main conservation efforts undertaken in Ethiopia are through Food-for-Work (FFW) program supported by World Food Program (WFP) and other governmental and non-governmental organizations (NGOs) (Hurni, 1993; Abera, 2003). At present farmers are trying to construct soil and water conservation measures at individual basis on their farmland in order to protect soil erosion.

Despite these efforts, it has been demonstrated that some farmers who put up the erosion controlling structures with incentives of FFW destroyed the structures in the absence of continue incentives (Bekele and Holden, 1998). Some of the reasons for the failure and low adoption of the introduced SWC structures by individual farmers are lack of participation of farmers in the planning process (top-down approach), inappropriateness of the technologies, institutional and organizational problems, non consideration of traditional conservation (Abera, 2003). A technology is abandoned by farmers not because farmers are resistant to change or not because of inherent attribute of the technology it self rather the introduced technology may not consider the main socio-economic, demographic as well as institutional factors of individual farmers.

Different studies have identified and discussed the factors that affect farmers' adoption practices (Bekele and Holden, 1998; Ervin and Ervin, 1982). SWC technologies that conserve soil may not be compatible with the socio-economic settings of the farmers and also may be expensive in terms of labor as well as capital because they require the limited resources the farmer has and end up with little success. This makes the importance of investigating the factors associated with adoption or non-adoption of a given technology to be imperative in the study area.

1.2. Statement of the problem

One of the immediate problems facing Ethiopia today is land degradation, particularly soil and vegetation degradation. Soil erosion is a very severe problem in the highlands of Ethiopia especially in Northern and Central highlands of Ethiopia (Hurni, 1993).

According to the Soil Conservation Research Project (SCRP) 1986, estimation about one billion metric tones of soil are eroded every year from Ethiopia. Similarly, the Ethiopian Highlands Reclamation Study (EHRS) estimated that the rate of land degradation would cost ETB 15,261 million between 1983 and 2010. Of these cost, about 78% is due to losses in the cropping area and about 22 percent due to decreased livestock production. The estimated cost of soil degradation is based on the assumption that the current rate of erosion will remain constant at a market price of 1983/84. The estimated cost of soil degradation on the highlands did not take into account the downstream effects of soil erosion (FAO, 1986).

The main facets of such degradation problems are deforestation, over grazing, cultivation of marginal lands and soil fertility depletion that can attribute to population pressure (Hurni, 1993). The same author argued that, with the current trend of population growth, there is a poor prospect of ecological sustainability and economic viability of the current agricultural practices unless an effort is made to integrate development in family planning, environmental rehabilitation, and agriculture is supported with enabling policy.

Loss of arable land due to soil erosion is a wide spread phenomena in the highlands of the Amhara region, which accounts for about 66 percent of the total area of the region (Lakew, et al, 2000).

The highlands of Wollo are one of the severely degraded areas because of its dissected nature of the land escape and high population pressure. Specifically, North Wollo has a long history of settled agriculture dominated by cereal-based farming systems and common drought prone which has provoked chronic food insecurity and occasional famines (FAO, 1986).

Meket *Woreda* of North Wollo is one of the highly affected area by sever soil degradation. The most important technical constraints are soil erosion and declining soil fertility (SOS Sahel, 1997). Thus, in the study area the situation of soil erosion is getting sever due to the dissected nature of topography and torrential rains falling during the rainy season. Such problem therefore not only reduces agricultural productivity and income but also pose a threat to household food security in the study area.

Efforts to conserve soil resources and prevent soil degradation date back to the 1970s and 80s in the study area. However, the efforts made so far have had limited impact in controlling soil erosion problem in the area. In many cases the soil conservation structures built were dismantled by farmers because of lack of incentives and interests of them.

Due to different reasons, the soil and water conservation measures of the study area don't come significant change in arresting soil erosion as well as some of the farmers don't construct and maintain SWC structures.

The limited success of the efforts highlights the need to better understand the factors that encourage or discourage the adoption of soil and water conservation practices.

Thus, it is difficult to generalize about the determinants of adoption of soil and water conservation technologies in different regions of the country because of the differences in agro ecological and socio-economic settings under which farmers operate. In view of this, it would be worthwhile to assess the factors affecting the adoption of soil and water conservation technologies. Therefore, this study attempts to assess the factors that determine farmers to adopt soil and water conservation technologies in Meket *Woreda* of North Wollo, ANRS.

1. 3. Objectives of the Study

The general objective of the study is to assess and analyze the factors that determine farmers' soil and water conservation technology adoption in Meket *Woreda* of North Wollo.

The specific objectives of this study are:

1. To describe the current and common soil and water conservation practices undertaken in the study area.
2. To identify the determinants of soil and water conservation structures adoption in the study area.

1.4. Research Questions

1. What are the current and common soil and water conservation measures practiced in the study area?
2. What are the determinant factors that affect the adoption of soil and water conservation measures in the study area?

1.5. Significance of the Study

The farming system of small holder farmers is not only diverse and complex but also risk-prone. Research institutions that aim to develop improved technologies for farmers who operate under complex farming situations, therefore, have a major challenge. Farmers need to understand the diversity, not only as one moves across ecological zones and regions but also across diverse farming system to meet the diverse needs with different cultures, educational back ground and aspirations even with in a given zone.

Despite many research works and proposals in combating and reversing soil degradation, it continues to prove to be a substantially pervasive problem. And the rural poor find themselves trapped in a vicious cycle of poverty and soil erosion fuelled by lack of relevant knowledge and appropriate technologies and opportunities to overcome such problem and generate adequate income to their livelihoods. The determination of factors influencing decision on practicing soil and water conservation is essential in taking measures to alleviate the constraints affecting adoption of soil and water conservation structures. Identification of factors that accelerate or hamper the adoption of technologies can enhance the formulation and the implementation of the technology dissemination programs. Thus, this work plays its own share for researchers and extension specialists to utilize the results of this study in modifying research and extension activities.

1.6. Scope and Limitation of the Study

The study was conducted in the North eastern parts of Ethiopia and the generalizations made based on the findings would be more applicable to the location of the study. In addition, the result of this study might be applicable to other areas in the parts of the highland where similar situations may prevail. However, the result of this study did not adequately address the trade-offs that emanate from the differential costs and benefits accrued to different agents involved in soil and water conservation at various levels. More specifically, the study leans toward household's decisions on the technical issues, i.e., soil and water conservation without eliciting the position of the state and community vis-à-vis in relation to that of households in the decision-making processes of soil and water conservation practices which are often difficult when extension planning is carried out.

Taking into account the financial resources and time shortage to carryout the research on the extended period of time through repeated field visits to collect primary as well as secondary data, this study was conducted through cross sectional study design. It is cross sectional with regard to time of investigation and study population. A one-shot or single field visit was undertaken to collect the required data for the study.

Thus, the delimitation of the study area to a single *Woreda*, 105 samples households and the time of data gathering and financial scarcities are the major limitation of the study.

1.7. Organization of the Thesis

The thesis is divided in to six chapters. Chapter one elaborates the introduction part of the study including background and problem statement, objectives, significance as well as scope and limitation of the study. Chapter two presents literature review, which encompasses definition, empirical adoption studies and conceptual framework. Chapter three deal with the description of the study area. Chapter four deal with research methodology which includes both qualitative and quantitative approaches of the study. In chapter five the results and discussions are presented and finally, chapter six presents the summary and conclusions part.

2. LITERATURE REVIEW

2.1. Definition of Terms and Concepts

Soil and Water Conservation(SWC): The improvement or improved management of the two resources "soil" and "water" to maintain (support, increase) in a medium to long term perspective of the production capacity of the resources, often measured in terms of yield(WOCAT, 2004).

As Rogers (1983) **Adoption** is *"...the mental process through which an individual passes from first hearing about an innovation to final adoption."*

Tyndall (1996) argues that in order to appreciate the process of adoption, it is important to examine what the technology brings not only to the farmer but also to the farm and the whole social system.

Franzel et al (1998) defines adoption potential as:
"The technical feasibility, economic viability and social acceptability of a technology when managed at field scale by a target population of farmers."

Adoption of Soil and Water Conservation Measures: The process of accepting and implementing modern soil and water conservation technologies by the farmers of an area through experts and development agents for better land management practices (Yohannes and Herwege, 2000). Newly introduced SWC measures can be considered as adopted if the farmers continue to utilize them as part of their production system after the external assistance is withdrawn. The adoption of a technology can be assessed by analyzing farmers' attitudes, objectives and aspirations of whether they would like to use the introduced technologies as part of their farming system (Woldeamlak, 2003).

For this study farmers were classified into adopters and non-adopters of soil and water conservation measures depending on their behavior with regard to SWC practices.

Adopters of SWC measures: are those farmers who put into practices a given SWC structures such as terraces (stone bund, soil bund and stone faced soil bund) introduced in their community and practiced in a sustained basis.

Non-adopters of SWC measures: are those farmers who choose not to practice SWC structures or did so but later abandoned them.

2.2. The Innovation-Diffusion Theory

One of the most known sociologists who have done a lot of work on the adoption of agricultural innovations is E.M.Rogers. Since this work is centered on the adoption of an agricultural innovation (soil and water conservation technologies aiming at improving agricultural productivity and natural resource conservation), his work has been largely used in the theoretical setting.

The innovation-diffusion theory as elaborated by Rogers (1983) provides the theoretical foundation for this study. Rogers (1983) defines diffusion as "*the process by which an innovation is communicated through certain channels over time among members of a social system*". And an innovation, according to Rogers (1983) is "*an idea, practice, or object that is perceived as new by an individual or other unit of adoption.*" For the purpose of this study, soil and water conservation practices such as stone/soil bunds etc are considered as innovation.

The innovation-diffusion model states that a technology is passed on from its source to end users through a medium of agents and its diffusion among potential users for the most part dependent on the personal attributes of the individual user. The model assumes that the technology in question is appropriate for use unless hindered by the lack of effective communication (Obony, 2000).

A number of factors act together to influence the diffusion of certain innovation. The four major factors that influences the diffusion process are the innovation itself, how information about the innovation is communicated, time and the nature of the social system into which the technology is being introduced (Rogers, 1983). Diffusion/adoption research analyses how these factors and a number of other factors act together to ease or obstruct the progress of the adoption of a specific technology among its final user (Surry, 1997).

Surry (1997) mentions the four most widely used and closely interrelated concepts of diffusion discussed by (Rogers, 1983). These are: innovation decision process, individual innovativeness, rate of adoption and perceived attributes. Each of are discussed as follows.

Innovation Decision Process: this concept describes diffusion as a process through which an individual passes over time and can be seen as having well-defined stages. Rogers (1983) identifies five stages in the innovation-adoption process. The stages are knowledge, persuasion, decision, implementation and confirmation. According to this theory, potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation and confirm (reaffirm or reject) the decision to adopt the innovation (Surry, 1997).

Individual Innovativeness: Rogers (1983) defines it as the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system. The central point of this concept is that individuals who are predisposed to being innovative will adopt an innovation earlier than those who are less predisposed (Surry, 1997).

Rate of Adoption: It signifies the relative speed with which an innovation is adopted by members of a social system (Rogers, 1983).

Perceived Attributes: the concept of perceived attributes implies that potential adopters evaluate an innovation based on their perception with regard to five attributes of the innovation. The attributes are: trialability, observability, relative advantage, complexity and compatibility. This theory states that an innovation will experience an increased rate of diffusion if potential adopters perceived that the innovation: 1) can be tried on a piecemeal basis before adoption, 2) offers observable results, 3) has an advantage relative to other innovations, 4) is not complex and 5) compatible with the existing practices and values (Rogers, 1983).

The adoption of innovation by farmers differs from one individual farmer to others. Some farmers possess some innovativeness which refers to the degree to which an individual is relatively earlier in adopting new technologies than other members of the community (Rogers, 1983). There are five main adoption categories as given by Rogers.

1. **Innovators:** These are farmers who are research minded and always want new ideas and changes. They are cosmopolites and have the ability to understand and apply complex technical knowledge and characterized by high educational levels, large farms, high income and high social status in the community. In general, innovators deviate from the norms of the community who don't have high regard for them as community leaders.
2. **Early adopters:** These refers to the well integrated members of the community who are often sought by neighbors for information and advice and are appropriate role models because they are not far ahead of the average individual in innovation. The farmer in this

group knows that he has to continue to earn the esteem if his position in the social system is to be maintained.

3. **Early majority:** These are the individuals who adopt new ideas just before the average members of the community. The education levels of this group, flow of information, participation in social organizations and contact with change agents are slightly higher than the average farmers'.
4. **Late majority:** Among this group, adoption is an economic necessity and a response to increasing social pressure. They are skeptic and only adopt when all or most members of the community have adopted. The majority of the people in the community have to favor the innovations before they can decide to adopt peer pressure is therefore necessary for this group to be motivated.
5. **Laggards:** These are usually the last to adopt new technologies. Members have no opinion leadership and believe in the past and are suspicious of innovations, innovators and change agents. They are usually the older members of the society, slow, have small farms, low income and little formal education.

It is important for change agents (researchers, extension personnel) to understand their clients, that are the adoption categories so that they can know how to deal with them and the best strategies to follow. The relative speed in which members of a social system adopt an innovation is usually measured by the length of time required for a certain percentage of the members of a community to adopt an innovation.

2.3. Adoption of New Agricultural Technologies

Agriculture is very dynamic- Farmers keep changing their management strategies based on their own experiences, those of their neighbors, resource availability, natural conditions and marketing trends. New technologies introduced by various organizations also affect farmers' normal practices. It is important to understand how these technologies being promoted fit into the complex pattern of agricultural dynamism in the farm level (CIMMYT, 1993) and how far the farmers have to change their normal practices in order to adapt the new technologies. Research organizations, extension institutions and rural development projects need to determine the level of acceptance of new technologies on farm and make changes accordingly.

Adoption of improved technologies in agriculture has attracted the attention of many development economists and sociologists because of the vast majority of the population in many developing countries derive its livelihood from agricultural production (Feder et al, 1985). The decision to adopt improved technologies involves fixed costs. The choice whether or not to adopt a new technology needs careful assessment of a large number of technical, economic and social factors. The technical feature of a technology have direct consequence on the decision making process (Colman and Young, 1989).

According to Rogers (1983), the characteristics of a technology are important determinants of adoption. The characteristics of a farmer such as age, household size, farm size, education, farm experience are few factors that influence adoption decision.

The effectiveness of the technology transfer is another important issue that is captured in adoption studies. A lot of resources are invested in demonstrations, field days, training and visits. Technology generation and transfer with farmers in a participatory way are essential for the success of any project. But it is important for researchers to study the effect of the technology after several seasons in order to know the proportion of farmers who still continue to use it, and for those who do not, the reason behind the discontinuation. Some technologies may be too far removed from their way of life or the extension package may not effective enough to familiarize the farmers with the new techniques (Obonyo, 2000).

In order to identify ambiguity that exist within the generation of a certain technology it becomes necessary to follow- up on the extent to which the farmers have accepted or rejected a technology. There are cases where a technology could be viable but acceptance is limited by lack of access to credit, infrastructure and extra inputs among others. If there are certain factors that influence the type of technology that farmers use, this information could be used to promote collaboration and linkages with other institutions that could link with the farmers and thus make it possible for them to be involved in other activities that would promote these particular factors. This would thus encourage communication between researchers and policy makers and even establish linkages between different Government and non-Governmental organizations.

2.4. Soil Degradation and Conservation Efforts in Ethiopia

The pressure of human intense activities and improper farming and mismanagement practices have posed serious threat to the sustainability of natural resources and in maintaining ecological balance. There is a widespread problems related with land degradation, intensive cultivation, overgrazing, deforestation, soil erosion, soil fertility decline, moisture stress, livestock feed and fuel wood crisis. These factors often interact with one another resulting in a re-enforcing cycle of "poverty, food insecurity and natural resource degradation trap" (Alemneh, 2003).

Pursuing food security objectives without protecting the natural resources base will be unattainable among the majority of small-scale farmers in Ethiopia: because the natural resources base (land, water, and forest) is fundamental to the survival and the livelihood of the vast majority of the people of Ethiopia. However these resources are under intense pressure from population growth, inappropriate farming, and mismanagement practices. Small holder farmers who depend on these resources, face constraints related to intensive cultivation, overgrazing and deforestation, soil erosion and soil fertility decline, water scarcity, livestock feed, and fuel wood crisis (Endris, 2006). The effect of soil erosion can be considered at two stages-effects upon production. These includes; total abandonment of land, reduced crop yields, increased inputs and costs, reduced productivity of irrigated land etc. At the same time, the consequences of soil erosion can accelerate landlessness, lower food supplies, lower of croplands, increase labor requirement and lower income (FAO, 1986).

There is a great concern particularly in the Ethiopia highlands about land degradation resulting from soil erosion and its impact on agricultural production. Improving the natural resources base is central to an effort to arrest this vicious cycle and improve the productivity of small holder farmers who constitute the largest proportion (45.5%) below the poverty line (FDRE,1997). Thus, addressing the root causes of reinforcing cycle of declining crop and livestock productivity, natural resources degradation highly associated with population pressure and vulnerability among the vast number of resource poor farmers is a crucial challenge facing Ethiopia. Despite the increasing pace of land degradation in the form of soil erosion and consistent with old development thinking which down played the role of agriculture, the issue of conserving agricultural land was largely neglected by policy makers until the early 1970s. The magnitude of the problem was fully realized and the problem attracted policy attention only after the devastating famine of Wollo in 1973/74 (Shiferaw and Holden, 1999). There was no government policy on soil conservation and natural resources management in Ethiopia prior to the 1974. The 1974 famine was the turning point in the Ethiopian history in terms of establishing a linkage among degradation of natural resources, famine and natural resource conservation including soil and water conservation. There was a more direct linkage in the public eye between highly degraded land and those affected by drought and famine in the Ethiopian highlands (Shiferaw and Holden, 1999).

Soil erosion in the Ethiopian highlands in general and the highlands of the Amhara region in particular has a major concern for many years. Loss of arable land due to soil erosion is a wide spread phenomenon in the highlands which account for 45% of the Ethiopia's total land area and about 66% of the total land area of the Amhara region (Lakew et al ,2000). Soil erosion by water is the dominant form of erosion in the Amhara region. The area that are severely affected by soil erosion in the region can be found in Wag Hemra and North Wollo followed by North and South Gondar Zones and Eastern parts of South Wollo and North Eastern parts of North Shewa (BoA, 1997). Topography, rainfall, wind, lack of vegetation cover, soil properties, land use and management practices are the immediate causes of soil erosion in the region (BoA, 1997).

2.5. Empirical Studies on the Adoption of SWC Technologies

Determinants of the adoption of soil and water conservation technologies have been studied by many agricultural interventions by many projects.

According to Ervin and Ervin (1982), personal factors (education level, attitude of farmers towards SWC conservation), Physical factors (soil erodability, topography, etc.), economic factors (level of economic return, debt, off-farm income, farming type, risk aversion) and institutional factors (training and technical assistance, cost sharing or government assistance) influence farmers' decision on soil and water conservation. They found variables related to personal characteristics (such as education), perception of the degree of erosion problem and farm experience to be significant. Apparently farmers' perception of erosion potential is one of the potential factors influencing farmers' decision in adopting soil conservation practices. A group of economic factors, such as transfer of farm to children, off-farm incomes, and debt, exert strong effects on the adoption decisions of farmers.

Zake (1992) hypothesized that contact of extension workers, compatibility of conservation technologies, government assistance, and tenure arrangement play the major role to examine the potential factors affecting soil conservation investment by farmers. Similarly Tupahirwe (1992) showed that socio-economic and policy issues though very interrelated factors, affect the failure or/and success of conservation investment in Uganda. The interrelated issues include customs of users and government policy, tenure, extension service and assistance.

Yohannes (1992) showed that factors such as technology characteristics, tenure, land fragmentation, age and education, steep land is prone to soil erosion and perception of the farmers' on soil and water conservation were identified as a barrier to physical soil conservation practices. This study revealed technology characteristics (nature and design), tenure (frequent land distribution) and land fragmentation affected negatively and significantly the adoption decision. On the other hand, among household characteristics, age and education level of household head affected adoption decision negatively and positively respectively.

Featherstone and Goodwin (1993) reported that an older individual who is looking at a shorter time horizon might not be able to recoup all of the benefits from conservation investment.

Sureshwaran *et al.* (1996) hypothesized that factors such as orientation to farming, education, and cost-sharing or government assistance affected significantly the decision behavior of farmers on soil conservation practices. Moreover, they showed that farm size, tenure arrangement, and reduction in land intensity, measured by land-labor ratio; affected farmers' decision on soil conservation practices. Contrary to the expectation forwarded, income and education did not dictate adoption.

Bekele and Holden (1998), examined factors of affecting soil conservation decisions of peasants in the central highlands of Ethiopia. They found that perception of the threat of soil erosion, household characteristics (education, age, and family size), land and farm characteristics, perception of technology-specific attributes and quality differentials, were important factors in shaping conservation decisions of peasants.

Households with large human capital may invest more in conservation (Pender and Kerr, 1998). This is precisely because soil conservation structures are labor intensive to build and maintain and hence households with large human capital may invest more in conservation. The larger the family, the higher the probability that future generation will form the land and reap the future benefits of conservation investments (Featherstone and Goodwin, 1993). However, family size is found to have a significant negative correlation with the adoption of a modified type of structure. This might be due to the relation between larger family size and the corresponding higher demand for food in the household. In a family with a greater number of mouths to feed, competition arises for labor between food generating off-farm activities, like daily labor, and investment in soil and water conservation. Under such conditions the satisfaction of immediate food needs is given higher priority and labor is diverted away from conservation (Wegayehu, 2003).

Lapar and Pandy (1999) undertook a microeconomic analysis of adoption of contour hedgerows by upland farmers in the Philippines to identify the factors that determine adoption. They found that adoption depends on several farm and farmer characteristics. They concluded by calling the need to develop a range of cost-effective technologies and particularly pointed that in the more marginal environments, on-site benefits alone may not justify investment in soil conservation.

Farm size is often correlated with the wealth that may help ease the needed liquidity constraint. Some empirical studies found that large farms are more likely to use conservation technology than small farms (Bekele and Drake, 2003). However, the land holding per economically active person in the family is found to have a very significant and significant negative correlation with modified and recommended type of conservation structure, respectively. It indicates the preference of farmers with large land holdings per economically active person in the family to invest less or not to invest at all in conservation. This result neither supports the argument that larger land holdings, as associated with greater wealth and increased availability of capital, make investment in conservation more feasible, nor that wealthier people are willing to bear more risk than poorer people (Wegayehu, 2003).

In the Ethiopian context, recent studies in different parts of the country found that tenure insecurity generated by fear of further redistribution of rural lands was the principal factors explaining farmers' unwillingness effort in measures to improve soil conservation and enhance fertility (Bekele and Drake, 2003). Empirical studies in different parts of Ethiopia reported a positive and significant effect of the slope of a plot on the decision to adopt soil conservation structures (Gebremedhin and Swinton, 2003).

Farmers' perception of soil erosion and their subsequent conservation behavior have mixed results (Tesfaye, 2003). In some studies, there was no substantial relationship between soil erosion perception and farmers' conservation behavior, whereas in others, there were direct links. For instance, the perception of erosion was found to be important to the adoption behavior of SWC in the Philippines and at Andit Tid, Ethiopia. Farmers' decisions to retain conservation structures are positively and significantly related to soil erosion perceptions, attitude towards new technology and exposure to new practices. Such was not the case in Tanzania where farmers' perception of the soil erosion problems fails to explain household behavior towards adoption of improved SWC practices. And even more, the Tanzanian study found that non-perception of the soil erosion problem does not always translate to households being unwilling and/or unable to use improved soil conservation measures summing up such observations. Positive environmental attitudes towards the protection of soil and water resources are a necessary but not sufficient condition to bring about the adoption of conservation programs at the farm level.

Abera (2003), in Farta *Woreda* of South Gonder Zone resulted in farm size and perceptions of the benefit from conservation activities positively and significantly affected the decision of farmers towards soil and water conservation activities. Where as distance of farm plots from homestead, involvement in off-farm activities and tenure in security were found negatively and significantly influence farmers' adoption decision of SWC structures.

In a study undertaken by Girmachew (2005) in the Environs of Simen Mountain National park of ANRS, out of twelve variables fitted in the logit model: farm experience, the total household labor in man equivalent, development agent visit, farmers levels of perception on soil erosion were statistically and significantly related to the adoption of soil and water conservation practices by farmers.

Socioeconomic and institutional factors influence the level of investment households committed to SWC. And size of cultivate land ,ration of economically active labor to the size of own farm are, livestock ownership farmers perception level of soil erosion, type of crop usually grown on farm land, the farmland fragmentation are significantly related to the adoption of SWC practices by farmers (Kumela, 2007).

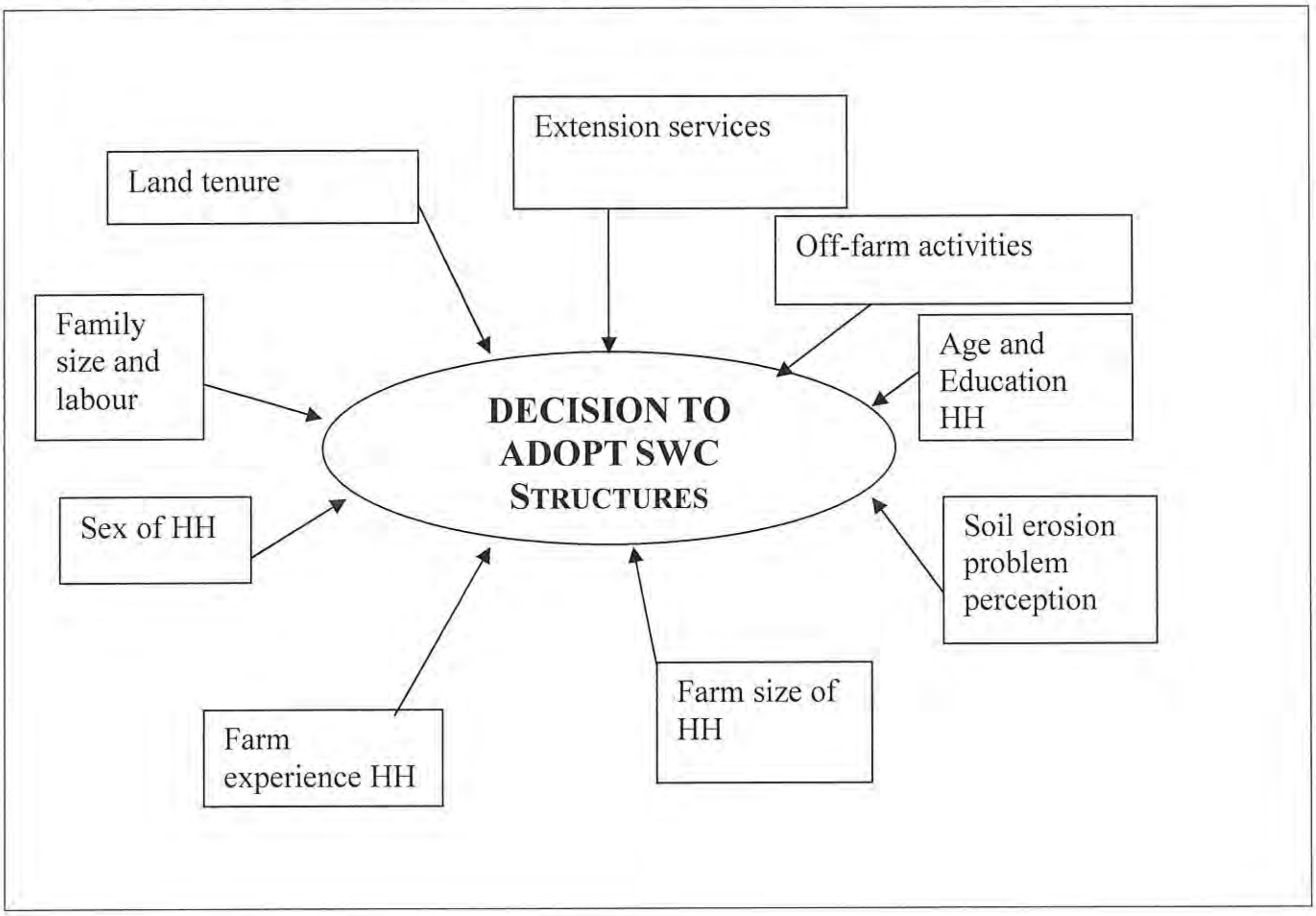
Generally, we can understand that different empirical studies have been carried out to see the direction and magnitude of the influence of different factors on farmers' decision behavior regarding adoption of new agricultural technologies like soil conservation practices. The summary of such literature indicates that farmers' response to a technology is influenced by personal and household characteristics, farm endowments, social, institutional, and other related factors.

Therefore, the above evidences and reviews of studies signify the importance of location specific studies to identify the major factors, which are barrier or facilitator to the adoption of a technology, and to recommend on the basis of the results for better achievement.

2. 6. Conceptual Framework of the Study

The conceptual framework of this study is based on the soil and water conservation technology adoption. The measures of adoption in this study is the actual physical presence of conservation structures on farmers' plot of land and farmers were asked whether conservation structures are done in their field and still exist in each plot of land. In this study adopters are farmers who have a plot of land on which conservation structures have been put up. Thus, the dependent variable is a function of demographic, socio-economic and institutional factors.

Figure 1. Conceptualization of the hypothesized factors that influence SWC adoption



Adapted from Abera Birhanu, 2003.

3. DESCRIPTION OF THE STUDY AREA

3.1. Location

The study area, Meket *Woreda* is located in North Wollo Administrative Zones of the ANRS. Meket is 665 km furthest from the capital of the country Addis Ababa, 215km far from the capital of the region Bahir Dar, as well as 140km furthest from the capital of the Zone, Woldia. The capital of the *woreda* is known as Filakit. Meket *woreda* is boarded with 6 *woredas*; Bugna and Lasta *woredas* in the North, Wadla and Dawnt *woredas* in the south, Gubalafto *woreda* in the east and Tach-Gayint and Lay-Gayint *woredas* which are found in South Gondar administrative zone in the west.

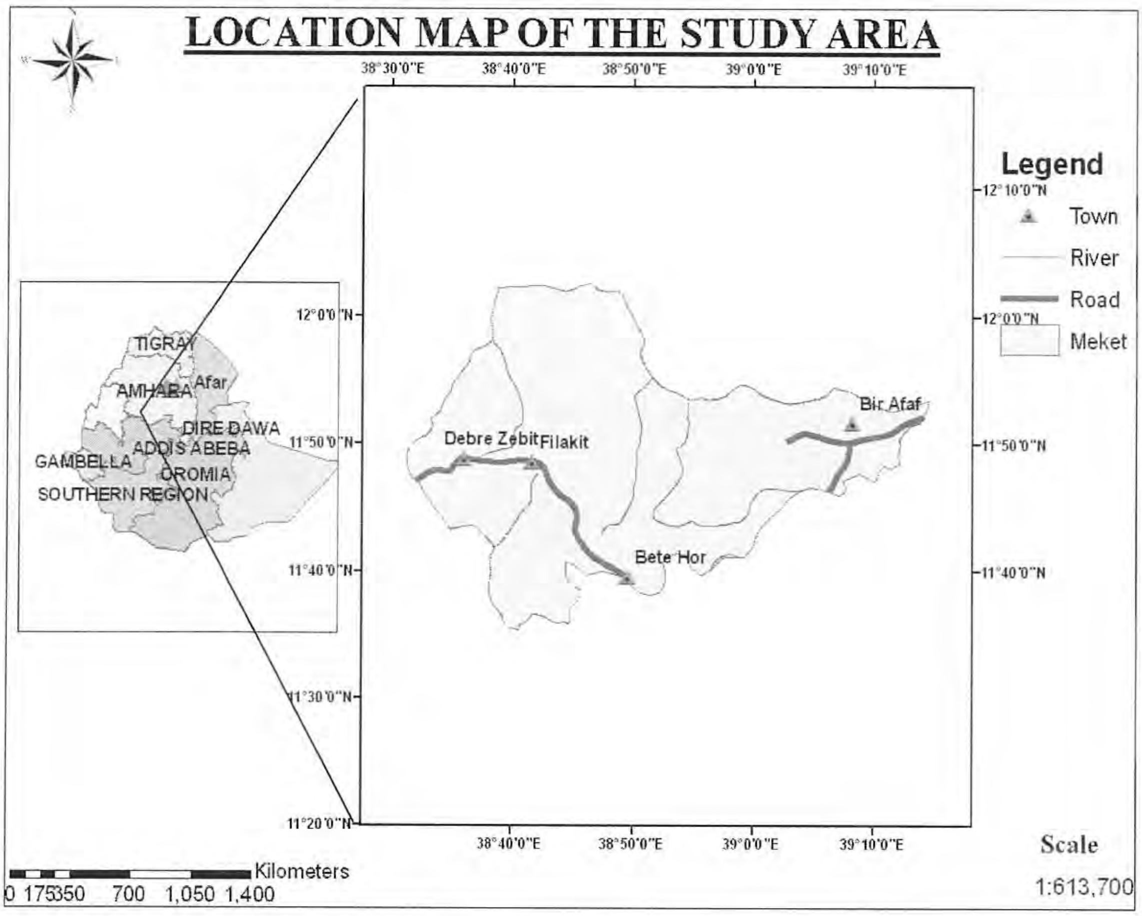


Figure 2. Map of the study area.

Source: Own construction using available data.

3.2. Area, Topography and Land Use System

The *woreda* has 45 rural and 2 urban *kebeles*. The total area of the *woreda* is about 191,148 ha. The topography of the *woreda* includes rugged (65%), plain (28%), mountainous (4%) and the remaining 3% is gorge/valley. With regard to the land use system of the *woreda* about 43,584 ha is cultivated land, 15,152 ha is grazing land, 7,370 ha is covered by forest, 46,630 ha is covered by bushes and shrubs, 39,528 ha is a settlement land, 11,592 ha is degraded land and the remaining 23,184ha is covered by other resources. The average land holding size of the *woreda* is about 0.75 ha/household.

3.3. Population

According to the 2007 national census of the country, the total population of the Woreda is about 227,338 of which 114,731 (50.47%) are males while 112,607 (49.53%) are females. The majority 215,590 (94.83%) of the population is living in rural areas and the remaining 11,748 (5.17%) are urban dwellers (CSA, 2007). According to the *woreda* information office the density of population is about 202 persons per km square and it is the densely populated.

3.4. Climate

Meket *woreda* is characterized by three major agro-climatic classification of Ethiopia. These includes highland, mid-highland, and lowland agro ecological zones commonly referred to as the *dega, woina-dega* and *kolla* respectively. With regard to the proportion of the climatic condition of the study area about 60% is the mid-highland, 30% is highland and the remaining 10% is the lowland climate. This shows that most of the parts of the study area lay within in the mid-highland agro ecological zones. The average annual rainfall of the study area ranges from 600-1000 mm. It is bi-modal in character.

3.5. Farming System

Agriculture is the main economic activity and livelihood source of the people of the study area. It is characterized by mixed farming that includes both crop production and livestock rearing.

Crop production is one of the most important components of agricultural activities on which most rural farmers practice and depend on for their living. The main crops grown widely in the area are *teff*, wheat, *wassera* (mixture of wheat and barley), barely, bean, pea and lentil. Wheat and *wassera* are the most important annual field crop inters its coverage and preference by farmers. The annual crops are mainly used for domestic use and source of income. The major constraints of crop production are drought/shortage of rainfall, cultivated land shortage, erratic rainfall, frost, hail, crop insect pests and disease and low level of modern agricultural inputs.

Livestock production is also considered as the vital agricultural activity of the area. Livestock are considered as the important livelihood assets as they are used as a source of food, income, draught power and transporting of goods. The major livestock types reared in the *woreda* are oxen, cows, heifer, bull, calf, sheep, goats, poultry, beehives, horse, mule, and donkey.

The major challenges in relation to livestock production in the area includes lack of grazing land, lack of feed, lack of improved breeds, livestock diseases and poor management practices.

3.6 Social Services

According to the *woreda* Health office, the health service, sanitation, and family planning service coverage of the *woreda* reaches 94.9%, 71% and 61% respectively. The ten top diseases of the study area are cancer, diarrhea, skin wounds, internal parasites, gastric, intestinal parasite worms, bronchitis, eye diseases and other wounds. The main problems in relation to this issue are lack of trained/educated manpower, high staff turn over (professionals) and lack of supplies of drugs.

In order to achieve the universal primary education to the citizens a number of schools are constructed and a lot of students are attending their education at the primary and secondary levels. According to *woreda* education office, all *kebeles* have at least primary school and the total primary school coverage reaches to 90.11%. As a result access to education in the *woreda* is very encouraging.

The main sources of drinking water to the rural people are hand dug wells, spring development, shallow wells and deep wells/boreholes. The safe drinking water supply coverage for the rural and urban areas is about 40.3% and 80% respectively. As compared to the total population of the *woreda* the drinking water supply is inadequate.

4. RESEARCH METHODOLOGY

4.1. Sampling Design

The sampling design of this study had involved a multi-stage stratified sampling technique. Both probability and non-probability sampling methods were employed in the sampling and selection process. Simple random sampling was used as a typical method of probability sampling technique while purposive sampling method was used as a key non-probability sampling tool in selecting units/elements of the study.

The first stage was the selections of the study *woreda* while the second, third and fourth levels of sampling were the selection of *kebeles*, villages and household respondents for the study by the following stages and process as follows

The study was undertaken in Meket Woreda of North Wollo, ANRS. The selection of the *woreda* was based on the severity of problems; it is drawn from sites for which data is available and primarily from areas where soil degradation problems are serious enough to warrant data collection. The area represents one of the highest case scenarios on the degree and rate of soil erosion and also high soil and water conservation intervention.

In the Woreda, there are 45 rural and out of the total rural *kebeles*, based on the information obtained from the *woreda* agricultural office 10 *kebeles* which don't extensively practiced soil and water conservation and less suspitability to soil erosion because of the flat nature of the landscape were excluded from the selection. From 35 rural *kebeles* with severe soil erosion problem and high soil and water conservation practices by farmers, 4 *kebeles* were selected randomly as samples for the study.

Within the selected *kebeles*, villages were selected randomly through simple random sampling method. Villages were selected proportional to the number of villages in the selected *kebeles*. Unfortunately, there are 5 villages in each *kebele* with a total of 20 villages in the 4 *kebeles*. Two villages were selected from each of the four Kebeles as sample for the study. As a result, a total of 8 villages were selected from the four *kebeles* through simple random sampling method using lottery draw technique (Table 1).

Table 1. Distribution of sample households by *kebeles* and villages

***Kebeles* Name**	**Villages Name**	**Total HHs**	**Sample size**
Hana-mequat	***Hanna***	125	14
	Agur	143	17
Enat-guya	***Mequat***	105	10
	Yebeles	115	12
Assassa	***Michael***	150	18
	Gafat	103	10
Zibe	***Zibe***	109	11
	Dasinja	121	13
Total		971	105

Source: household survey, 2009.

The selection of the sample households in the selected villages was followed the following steps and procedures.

Step 1: Establishing Sampling Frame

Before conducting the selection of sample households in the selected villages, sampling frame was established by taking the complete list of household heads from the record available in the *kebele* administration office. The actual and complete list of the sampling units/households was further checked by the Kebele leaders and key informants who know the household heads very well. The total household heads of the 8 villages were 971.

Step 2: Sample Size Determination

After getting the total number of household heads in the selected villages, the next step was determining total sample size of the survey based on the established sampling frame of the selected 8 villages.

Approximately 10 % (105) of the total households was taken as sample. The sample size in each selected village was made in proportion to the total household heads found in each village. The total sample size was distributed into the sample villages proportional to the total size of households in order to select the sample households proportional to the size of households in each selected villages (Table 1).

Step-3: Selection of Sample Households

Following the established sampling frame and determination of the total sample size of the study, the next step was selection of sample respondents for the household survey. A total of 105 sample households were selected through simple random sampling method using lottery draw technique. Household heads were the units of analysis for the study.

4.2. Sources and Methods of Data Collection

4.2.1. Types and Sources of Data

Quantitative and qualitative data were collected from different sources through various methods. These include both primary and secondary data sources. The importance of collecting and considering both primary and secondary sources through qualitative and quantitative methods of data collection was to complement and supplement the diverse data generated from different sources which in turn is used to make the data and the result of the research reliable.

Research data can be collected from various sources depending on the objective of the study and type of data to be analyzed. For the study both primary and secondary sources were used. Sample households, key informants and focus group discussants were the main source of primary data while the published and unpublished documents such as office records and reports, journals, proceedings, books, related thesis works were the key secondary sources of data.

4.2.2. Methods of Data Collection

Household Survey: is a typical method to collect primary data from the sample households. A structured questionnaire that has involved both closed and open-ended questions was constructed and employed to generate data from the respondents. Initially the questionnaire was prepared in English but it was translated into Amharic, the local language to make the question simple, clear and understandable to the respondents. Household survey was conducted through face to face interview between the respondent and the interviewer. Household heads were the appropriate respondents for the questionnaire designed for the survey. The main types of data collected from household survey were the household demographic socio-economic and institutional characteristics.

Household survey was facilitated by well trained enumerators under the close supervision of the researcher. Before the actual household data collection, one and half day training was organized to enumerators on how to manage the whole household survey task, interview and fill the questionnaire. Pre test was conducted prior to the household survey. This helped the researcher to know whether there is a need to modify the questionnaire based on the feedback from the pre test.

Focus Group Discussion (FGD): is one of the most important research methods used to collect qualitative data. FGD was held with farmers of the eight villages under the supervision of the researcher. Each group has a member of eight to ten (8-10) farmers who are selected purposefully for the study. These farmers were selected based on their perception level of soil erosion, plot location, main soil and water conservation practices on their farmlands.

A check list was prepared to guide the open-ended discussion with the identified FGD members. The data collected from the focus groups were qualitative and general which reflects causes of soil erosion, consequences of soil erosion, and practices of soil and water conservation on their farm land.

Key Informant Interview: is one of the other methods used to collect primary data. It was used to collect in depth information about soil and water conservation practice of Meket *Woreda*. The information gathered through key informant interview was used to complement and supplement the data collected from household survey through structured questionnaire and other sources too. In this study, the key informants were development agents, *Woreda* soil and water conservation experts and *Woreda* agro forestry experts. Check lists were developed and used to guide the interview.

Direct Observation: is one of the important methods of primary data collection. In this study, it was carried out through systematic watching, listening and recording of different data. It helps to generate ideas helpful to modify questionnaire for survey, group discussion and key informant interview and also to acquire information about the physical setting of the area, conditions of soil erosion, status of the present soil and water conservation practices.

Transect walk with farmers, Development agents, and *Kebele* Administer was conducted focusing mainly on the observation of degraded areas, soil and water conservation activities of individual farmers' plots, deforested areas, and management practices in the study area.

The main source of secondary data and information for this study were published and unpublished documents such as plans, reports and records from various government offices found at *keble* and *wereda* level. The main types of secondary data collected under this category were location, area size, boundary, population, economic activities, natural resources bases, socal services.

Data were collected from the *Woreda* Agricultural office, the *Kebele* documents, Development Agents Office known as Farmers Training Office (FTC). In addition to these different books, dissertations and theses were reviewed for this research as secondary sources of data.

4.2.3. Method of Data Analysis

The data generated was analyzed using descriptive statistic and use of econometric model. Based on survey data, demographic, socio-economic and institutional characteristics of sampled households were described with respect to adoption of soil and water conservation measures by employing descriptive statistics. Logit model of econometrics was employed to identify the determining factors of soil and water conservation practices in the area.

Descriptive statistics were important to have a clear picture of the characteristics of sampled units. By applying descriptive statistics such as mean, standard deviation, frequency of appearance, etc., one can compare and contrast different categories of sampled units (in this case farm households) with respect to the desired characters so as to draw some important preliminary conclusions.

The study utilized a probability model specified with adoption of soil and water conservation measures as a function of series of demographic, socio-economic and institutional characteristics of households. The dependent variable is a dummy variable, which takes a value of zero or one depending on whether or not a household is to adopt SWC measures(i.e. adopter of SWC measures=1, non-adopter of SWC measures=0).

Logit model was used to estimate dependent dichotomous variables. Although linear probability model is the simplest method, it is not logically attractive model, in that it assumes that the conditional probability increases linearly with the value of explanatory variables. Unlike linear probability model, logit model guarantees that the estimated probabilities increase but never step outside the 0 – 1 interval and the relationship between probability (Pi) and explanatory variable (X_i) is nonlinear (Gujarati, 1998).

Thus, a logistic model was used to identify the determinants of adoption of SWC measures and to assess their relative importance in determining the probability of being an adopter of soil and water conservation measures.

The functional form of Logit model is specified as follows, Gujarati (1998)

$$P_i = E(Y = 1/X_i) = \frac{1}{1 + e^{-(\beta_o + \beta_i X_i)}} \tag{1}$$

For ease of exposition, we write (1) as:-

$$P_i = \frac{1}{1 + e^{-Z_i}} \tag{2}$$

The probability that a given household is adopter of SWC measures is expressed by (2) while, the probability for non-adopter of SWC measures is:-

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \tag{3}$$

Therefore we can write:-

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} \tag{4}$$

Finally, taking the natural log of equation (4) we obtain:-

$$L_i = \ln\left[\frac{P_i}{1-P}\right] = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \tag{5}$$

Where Pi = is a probability of being adopter of SWC measures ranges from 0 to 1

Zi = is a function of n explanatory variables (x) which is also expressed as:-

$$Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \tag{6}$$

β_0 is an intercept

β_1, β_2 ------ β_n are slopes of the equation in the model

Li = is log of the odds ratio, which is not only linear in X_i but also linear in the parameters.

Xi = is vector of relevant household characteristics

If the disturbance term (U_i) is introduced, the Logit model becomes

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + U_i \tag{7}$$

4.2.4. Variables Specification and Working Hypothesis

Dependent Variable

The dependent variable of the study (Y_i), the dependent variable of the model: The logit analysis has dichotomous nature representing the observed status of the farmer in soil and water conservation practices adoption decision. In this case, 1 represents adoption of soil and water conservation practices with own initiatives and 0 non-adoptions of the practices.

Independent Variables

The independent variables of the study (X_i), the independent variable of the model: Farmer's decision to use a given soil and water conservation technology is influenced by the several demographic and socio economic characteristics of the household, the household's resource endowments, and institutional support systems.

Age of household heads (AGEHH): The age of a farmer can enhance or prevent the adoption of soil and water conservation structures. With age, a farmer may get experience about his/her farm and can react in favor of constructing and maintaining SWC measures. On the other hand older farmers are more likely reject conservation practices. Thus, age may have a positive or negative effect on the adoption of soil and water conservation structures.

Sex of household heads (SEX): sex of farmer is also hypothesized to have an effect on adoption of conservation structures. Male-headed households have the strength to construct soil and water conservation measures. Thus, this variable may have a positive or negative effect on the adoption of soil and water conservation structures.

Educational level of the household heads (EDULHH): It refers to the level of education attended by the household head up to the time of survey. The educational level of the target group is one of the important factors preparing the individual to receive new ideas. A highly educated farmer is likely to become more assertive and dynamic in the conduct of his /her economic and socio- political activities. It was hypothesized that those farmers with increased formal education are set out to use physical soil and water conservation practices because of increased information on soil erosion control techniques as well as the associated benefits and costs. Thus, educational level is expected to influence decision on using physical soil and water conservation practices.

Family size of the household (FAMSIZE): The effect of family size on the retention of conservation structures may be either positive or negative. Larger households will be able to provide the labor that might be required for maintaining conservation structures. On the other hand, large families may need more land to fulfill their subsistence needs. Since physical conservation structures occupy and then compete for the scarce productive land and hence larger families may tend to remove conservation structures.

Farm size in hectares (FARMSIZE): This variable stands for the total land area measured in hectare, which included cultivated and fallow land. Farm size is often correlated with farm income and wealth, which may ease the liquidity constraint to invest in land quality. Farmers with larger farm size have more cash to hire labor to undertake conservation investment and thus large holding promotes conservation decision positively.

Farm experience the household heads (FARMEXPER): This refers to the total number of years the respondent has spent in farming. With longer experience in farming, a wide knowledge and experiences are gained on the operation and conduct of traditional agricultural activities and methods of production. Thus, it is less likely that farmers with longer farm experience will be ready to accept changes and adopt new ideas and techniques. Hence, farm experience is expected to influence adoption of soil and water conservation practices negatively.

Land security (LASECURIT): if farmers feel that land belongs to them, it will have a positive effect on their decisions to invest in conservation practices. The fact that most physical soil and water conservation practices pay the farmers in the long term which implies that they need to have a longer planning horizon to reap the benefit of conservation. This situation is expected to increase the farmers' likelihood to invest in land conserving technologies. Hence, it is hypothesized that security of tenure will have a positive association with the adoption of soil and water conservation practices.

Farmers' level of perception of soil erosion (PERCEP): Farmer's awareness of erosion hazard and perception of the soil degradation problem is hypothesized to have a positive influence on the adoption of soil and water conservation practices. Farmers who have already perceived the problem of land degradation are more likely to adopt soil and water conservation practices than those who are not aware of it.

Off-farm income generating activity (OFFARM**):** It is the involvement of household head or his family members in off -farm and/or non -farm income generating activity. Farming system at study area is usually mono-cropping and farmers are also engaged in income generating activities out of their main agricultural activities. Off-farm income is a means to have more cash that is available to livelihoods of farmers which enhances farmers to hire labor to construct SWC measures. Off-farm activities can take labor away from agriculture and may decrease conservation investments. Therefore, in this study it is hypothesized that off-farm income is positively and negatively related with household soil and water conservation adoption.

Access to extension (EXTEN): This refers to farm household heads that have access to Extension service through visit by the development agent. Here, household heads access to extension service through the development agent visit believed to accelerate the effective dissemination appropriate agricultural information (i.e soil and water conservation practices) which has positive implication to farmers to make informed decision in their farm that facilitate increased production. Therefore, it is expected that access to extension service through a visit made by the development agent have a positive association with farmers' informed decision for enhanced agricultural production and adoption of soil and water conservation structures.

The Tropical Livestock Unit (TLU): It is the total number of livestock holding of the farmer measured in livestock units. Livestock are the farmers' important source of income, food and draught power, and an asset indicating the wealth status of the household. Hence, livestock-holding size is expected to affect adoption of physical soil and water conservation technologies positively.

The following table summarizes the above mentioned explanatory variables that are hypothesized to influence the adoption of soil and water conservation measures in the study area.

Table 2. Definition of explanatory variables

Variable name	Definition of variable
ADOPTER	Is a dichotomous dependent variable taking value of 1 if a household is adopter of SWC measures (stone/soil bund present) on at least on their farm and 0 otherwise.
AGEHH	Age of the household head in years.
EDUHH	Literacy status of the household head; 1if literate and 0 not
SEX	The sex of household head; 1 if male and 0 if female
FAMSIZE	Number of people in the household
FARMSIZE	The total size of cultivated farm land, in hectares
FARMEXP	The number of years a household head was involved in farming activity
OFFHH	Whether a farmer engaged in off-farm employment; 1 if a farmer has off-farm employment and 0 otherwise
TLU	Total Livestock holding in Tropical livestock unit (TLU)
PERCEP	Whether a farmer observes/perceives soil erosion as a problem in his/her plots; 1 if he/she perceives 0 otherwise
LSECURITY	Whether a farmer perceive a risk of loss of land in the future; 1 if the household head perceives risk of loss and 0 otherwise
EXTEN	Whether a farmer has access to agricultural extension service; 1 if a household head has access to extension service 0 otherwise

5. RESULTS AND DISCUSSIONS

This part, which is divided into three major sections, attempts to bring together the major findings of the study. In the first section, description of the current soil and water conservation measures practiced in the study area are forwarded. The second section tries to identify and assess the demographic, socio-economic and institutional characteristics of the total sample households (n=105) and presented using descriptive and bi variant analysis. The total sample households were categorized into two groups based on their adoption behaviors of soil and water conservation measures as adopter of SWC measures (n=68) and non-adopter of SWC measures (n=37) comprising 64.8% and 35.2% of the total sample households respectively.

While the last section is devoted to identify determinants of adoption of soil and water conservation measures by farmers in the study area using the result of the binary logistic model.

5.1. Description of Soil and Water Conservation Practices in the Study Area

Soil and water conservation involves the use of biological and physical measures to offset the effect of soil erosion. Biological or agronomic measures refer to the farming practices while physical measures aimed at controlling and diverting the runoff in the arable areas.

Basically, physical soil and water conservation practices are categorized into two: these are traditional and improved practices. These practices have both similarities and differences in terms of characteristics, construction, maintenance, effectiveness and problems and limitations.
Indigenous and improved measures have similar characteristics for the purpose of soil trapping and water harvesting. In cases, soil and/or medium to big size stones are required for construction. However, they are different in permanency, duration, labor source for construction and time of construction and design.

5.1.1. Indigenous SWC Measures Practices

According to farmers, indigenous soil and water conservation measures are simple structures of short term nature that could reshuffled each year to make better use of the soil captured above the structures for production and also to avoid rodent hostage and reproduction. The most common types of these practices implemented by farmers of the study area for soil conservation activities are traditional ditches (*boyi*), grass strips (*dib/weber*) and contour plowing (*agdem mares*).

Traditional ditches (*boyi*): are used to drain excess water from farmlands during high rain time especially in July and August and done most of the time by oxen with *maresha.* Traditional ditches are constructed every cropping season and run diagonally over the cultivated land. Farmers make ditches using ox plough. Depending up on the slope gradient of the farm plots, farmers make ditches with certain interval. The distance between two consecutive ditches decreases with slope gradient. However, the distance is not based on scientific measurement and varies from plot to plot. The main purpose of traditional ditch is to protect the soil from erosion. Sometimes farmers make ditches to drain water from flat fields during long growing season. The main advantages of traditional ditches is that it takes less time and can be made by oxen, hence, it requires less time and labor as compared to other conservation measures. In FGD with farmers and key informant interviews with development agents and *woreda* experts modern technology known as tie-ridger is disseminated to farmers in order to drain excess water from farmlands during the rainy season and now farmers in addition to traditional ditches use it as other means of soil and water conservation tools by draining excess water.

Grass strip (*dib/weber*): is the other traditional mechanisms used by farmers of the study area for soil conservation activities. Farmers in FGD stated that *dib* is important in order to reduce the speed of runoff during high rain as well as for fodder production for livestock feed known as *durqa* in local language.

Farmers having relatively larger cultivated land leave unploughed strips within the farmland following the horizontal contour or at the boundary of their farmland for the purpose of decreasing flood hazard coming from up lands. The trapped soil over time developed on the strip will make the soil more fertile. This is suitable for growing of grass for their cattle. After some time, farmers plough some or all parts of the strip and leave another strip below or above the old once. The different parameters, length, width and distance between two strips vary from plot to plot.

Obviously, this practice demand no labor input except that farmers keep some parts of the land out of cultivation. According to the farmers, this practice will not be experienced in the future because of land shortage.

Contour plowing (*agdem mares*): according to farmers, it is the plowing across the slope to increase the time for rain water infiltrations and to decrease the speed of runoff during high rain period.

In general farmers of the study area used these kinds of traditional SWC measures in addition to the introduced soil and water conservation structures.

5.1.2. Introduced Soil and Water Conservation Structures

Different types of soil and water conservation measures have been introduced to the study area since 1970s. These structures were introduced with the objectives of conserving, developing and rehabilitating degraded agricultural lands and increasing food security. The existing SWC structures introduced to the study area can be grouped into two based on the participation of farmers at individual and communal levels. These are soil and water conservation measures on individual farmland level by each farmer and SWC measures made on communal lands. Most of the structures of soil and water conservation measures were limited to dry seasons so as not to interfere with other farm activities and avoid difficulty of SWC work that arises from the wetness of soils. Introduced soil and water conservation structures in the study area can be categorized into SWC structures on individual and communal lands.

Soil and Water Conservation Measures on Individual Farmlands

The majority of soil and water conservation efforts made in the study area are directed to controlling soil loss from cultivated fields. The major introduced SWC measures on individual farmlands include stone bunds, soil bunds and stone faced soil bunds.

Soil bunds: These are embarkments constructed from soil along the contour with water collection channel or basin at its upper side. These bunds are constructed by throwing soil dug from basin down slope. They are constructed to control runoff and erosion from cultivation fields by reducing the slope length of the farm which ultimately reduces and stops velocity of runoff. These structures are effective in controlling soil loss, retaining moisture and eventually enhancing productivity of the land. Yet, since they are porous by their nature and constructed along the contour, farmers complained their water logging effect and frequent destruction from high runoff accumulation on embarkments.

These structures were installed at a vertical interval (VI) of 1-2.5 meter depending on the slope of cultivation land and are mostly found on the lower parts of the catchments where land is relatively flat and the rainfall is relatively low. Soil bunds are less permanent and durable structures mostly applied on rain fed, flat and gentle slopes in the study area.

Hand shovel, locally known as *akafa* is the main farm tool used for the construction of improved soil bund. These structures are constructed during dry season before land preparation.

Stone bunds: These are embarkments constructed by throwing stones from basin to uphill. Like soil bunds, embarkments of stone bunds are laid following contour fields.

Stone bunds are widely practiced where there is no shortage of stones to construct and when the farmlands are sloppy. The introduced stone bunds are widely distributed in catchments where severe soil erosion problems occur. These structures have similar characteristics in terms of effect, purpose and time of construction with that of soil bunds.

However, stone bunds are permanent and less durable structures constructed on gentle and stepper slopes. Soil and/or small and medium size stones are the main materials required for the construction of these structures. In the construction of stone bund the passage of water through a layer of stone is controlled by applying fine soil in between stones.

Figure 3. Common stone bund on farmlands that need maintenances.

Stone-faced-soil bunds: these are a combination of stone-soil for the conservation of soil and most of the time undertaken where stones and soils are much available in farmlands.

Table 3. SWC measures adopted by the sampled households

Types of SWC structures	Number	Percent
Stone bunds	27	40
Stone-faced-soil bunds	24	35
Soil bunds	17	25
Total	68	100

Source: Own survey, 2009.

Thus, the most widely adopted soil and water conservation structures at individual farmlands predominantly done by farmers in the study area are stone bunds, stone-soil (mixed) bunds and soil bunds. As the survey result indicated that among the total adopters of SWC structures, 40%, 35% and 25% of the sampled households constructed and maintained stone bunds, stone-soil(mixed) bunds and soil bunds respectively in the study area at individual farmlands(Table 3). During focus group discussion, farmers also confirmed that the most dominant form SWC structure undertaken on their farmlands are above mentioned one. Additionally they construct different kinds of traditional conservation measures especially during the rainy season like traditional ditches, contour plowing.

Farmers' acceptance and adoption of soil and water conservation measures depends on the perceived benefit from the SWC structures. As Woldeamlak and Sterk (2002) reported in order for farmers to accept and retain conservation technologies and willingly participate in conservation activities, the technologies to be put into operation should have perceivable benefits and need to be convinced of the benefits of soil and water conservation technologies through various means such as visits to other areas with successful implementation and demonstration.

In this regard farmers of the study area were asked the benefit they have got from those conservation activities and responded as follows.

Table 4. Benefits accrued from soil and water conservation structures

Benefit of SWC structures	Number	Percent
Reduced soil erosion	65	34.6
Increased crop yield	48	25.5
Maintains the land for the future	41	21.8
Controls flood	34	18.1
Total	188	100

Source: own survey, 2009; Multiple response analysis.

As indicated in table 4, farmers of the study area reported the benefits they got from the conservation structures implemented on their farmlands. The first benefit they realize from soil and water conservation measures constructed on their farmlands is the reduction of soil erosion (34.5%) followed by increased crop yield (25.5%) and maintains the land for future use (22%). This indicates that there is a consideration of the roles of SWC structures by farmers.

Most of the structures constructed on individual farmers plot are effective in controlling soil erosion. Most of the adopters of structures stated that the SWC measures found at the present time on their land are effective in controlling soil erosion and reduced on their farmlands as well as realize a change between plots of land that have SWC measures and those plots which don't have structures in productivity and soil fertility.

In this regard farmers in FGD underlined the effectiveness of soil and water conservation measures by stating;

"the differences between treated and untreated areas by soil and water conservation structures is not only on the amount of crop produced but also at the growing stage where crops and grasses show better performances on the treated areas".

And most farmers have the interest to construct soil and stone bunds on plots which need soil and water conservation measure. The current statuses of soil conservation measures implemented in farmlands are found in good position. In view of this, most of the surveyed adopter of SWC measures households stated that the structures are found in good position.

With regard to the frequency of maintenance of soil and water conservation measures, the adopters of SWC structure households were asked how frequent they maintain SWC structures. And the majority (55.9%) of the surveyed adopter households reported that the maintenance of the structures is every year in the slack season. While the remaining 44.1% of the surveyed households reported that maintenance of structures is done when damage happens to the structures.

The most important problem mentioned by most farmers for soil and water conservation measures was the competition of much labor with other farm activities especially during plowing and weeding time, the difficulty of ploughing by oxen, the expansion of pests, weeds and rats on the constructed structures.

About 31.5% of the sampled adopter of SWC structures described that the introduced measures need high amount of labor for construction and maintenance activities of the structures and compete high amount of labor for other farm activities in the study area. In focus group discussion, some farmers stated that the amount of labor to be invested in the construction of soil and water conservation structures is above their current labor capacities and pointed out that they need government assistance through food for work (FFW) program especially in most degraded lands by soil erosion during the rainy season. This also shows that SWC structures maintained in farmers plot needs high labor for construction. In addition to this, farmers also confirmed that SWC measures hamper the plowing of farmland by oxen especially the stone bunds.

Table 5. Constraints mentioned by farmers with regard to SWC structures

Problems	Number	Percent
High labor requirement	63	31.5
Difficulty to plough oxen	57	27.7
Favors the growth of pests, weeds and rodents	49	23.8
Occupies cultivable land	37	18
Total	206	100

Source: Own survey, 2009; Multiple response analysis.

Similarly 27.7% of the interviewed adopter households indicated that narrow stone terrace spacing makes it difficult or impossible to plough the slope in diagonal lines and turn the ox-drawn plough. In the same way 23.8% of the sampled adopter households indicated that the area occupied by SWC structures is not ploughed, so that weeds, pests and rodents were no longer destroyed and cultivated fields are infested.

The other shortcomings of the introduced SWC structures in the area addressed by FGD participants is that where rainfall is plenty, water logging is frequently observed along a narrow strip above the SWC measures because of lack of sufficient waterways.

Generally, farmers agreed that there is a need to prevent soil loss. Most of the interviewed farmers mentioned that soil erosion is one of the problems for the decline of crop production in the study area.

Soil and Water Conservation Structures on Communal lands

Different types of soil and water conservation structures have been undertaking especially on communal lands that are severely degraded in order to restore their productive capacity. These include area closures, hillside terraces, check dams.

Area closures: It is a closure of areas and restricting access to all human and livestock activities and allowing it to recover through natural process. These areas have been closed to improve land that are affected by severe erosion, and devastated areas. In order to facilitate the natural process, such areas have been planted with different species of trees. Trees planted in such areas include eucalyptus tree, acacia, *omedila, wanza* (cordia), *kitkita* (dodonia), etc. Such areas are also treated with other physical conservation measures such as hillside terraces and micro basins.

Hillside terraces: These are physical structures constructed on steep degraded areas and shallow soils along contours. The main objectives of constructing hillside terraces are to control runoff, allow sufficient time for infiltration of runoff and maintain the fertility of soils by filtering sediments and removing excess water. These structures are effective for watershed rehabilitation, biomass production and recharging water table if combined with other moisture conserving measures.

Check dams: These are structures constructed across the bottom of gully to reduce the velocity of runoff and prevent the deepening of and widening of the gully. According to the WARDO, the height of these structures reaches up to 1 meter and above and have adequate spillway for the safe disposal of water with apron at the foot of the check dam to dissipate energy.

Figure 4. Check dams constructed on communal lands.

5.2. Demographic, Socio-economic and Institutional Characteristics of the Sampled Households

5.2.1. Demographic and Socio- economic Characteristics

5.2.1.1. Sex, Marital status and Religion

Majority of the sample household (87.6%) were male headed households while 12.4% respondents were female headed households. Out of the male headed households, the majority (91.2 %) were found to be adopter of SWC structures while 81.1% were male headed from non-adopters of SWC measures (Table 6). Thus, the chi square test shows there is no significant relationship between household head sex and adoption of SWC measures. Soil and water conservation demands high amount of labor for construction and maintenance and done by male headed households.

Table 6. Distribution of sample households by Sex, Marital status and Religion

	Level of adoption of SWC measures						
	Non-adopter		**Adopter**		**Total**		X^2 **Statistics**
Sex of the household head	N	%	N	%	N	%	
Male	30	81.1	62	91.2	92	87.6	
Female	7	18.9	6	8.8	13	12.4	
Total	38 (7)	100	68	100.	105	100	0.807(ns)
Marital Status of household head							
Married	34	91.9	65	95.6	94	94.3	
Divorced	3	8.1	2	2.9	5	4.7	1.922(ns)
Widowed	0	0	1	1.5	1	1	
Total	37	100	68	100	105	100	
Religion of the household head							
Orthodox	36	97.3	64	94.1	100	95.2	
Muslim	1	2.7	4	5.9	105	4.8	0.534(ns)
Total	37	100	68	100		100	

Source: Own computation, 2009; Note: (ns), not significant.

About 94.3% of sample households were married while 4.7% and 1% were divorced and widowed respectively. The chi-square test shows there is no significant relationship between marital status and adoption of SWC measures (Table 6).

With regard to the religion of households 95.2% of the households were Christian (Orthodox) believers while the remaining 4.8% of households were Muslims. Similar to sex and the marital status of household heads, there is no significant relationship between religion of households and adoption of SWC measures (Table 6).

5.2.1.2. Age of the Household Heads

The analysis of the farmers' adoption of SWC structures by age showed some differences between the two groups. About 88.5 percent of the sample households were in the age group of 22-64 years in which 55.2% from the age bracket of 22-40 and 33.3% from the age bracket of 41-64 years (Table 7).

The percentage of farmers who don't adopt SWC structures differ much more among age groups. Accordingly, 81.1%, 18.9% and 0% of non-adopter farmers had age range of 22-40, 41-64 and more than 64 years respectively (see table 5). Thus, the majority (81.1%) of non-adopter farmers are young with age group in between 22-40 years old. While the percentage of farmers that adopt SWC structures was more or less uniform among age groups especially with age group 22-40 and 41-64. As a result, 41.2%, 41.2% and 17.6% of adopters of farmers had age range of 22-40, 41-64 and more than 64 years (Table 7).

Mean age of sample household heads, non-adopters of SWC measures households and adopters of SWC measures were about 42.28, 34.41 and 46.56 years with standard deviation of 12.036, 8.265 and 11.63 years respectively. The statistical analysis revealed that there is significant mean difference in age of adopter of SWC measures versus non-adopter of SWC measures households at 5% significance level. This shows as age of the household head increases the likelihood of being adopter of SWC measures also increases. This is probably due to the fact that, when age increases through experience in farming, knowledge, skills, and attitudes are gained to practice soil and water conservation structures and this increases the tendency of being adopter of SWC measures.

Table 7. Distribution of age of the sampled household heads

Age of the Household Head	Non-adopter		Adopter		Total		X^2 Statistics
	N	%	N	%	N	%	
22-40	30	81.1	28	41.2	58	55.2	
41-64	7	18.9	28	41.2	35	33.3	
Greater than 64	0	0	12	17.6	12	11.4	
Total	37	100	68	100	105	100	16.998***
	Non-adopter		**Adopter**		**Total**		**t- Statistics**
Age of the Household head	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	5.624**
	34.41	8.265	46.56	11.63	42.28	12.036	

Source: Own survey, 2009; Note: *, significant at 1%; **, significant at 5%.**

5.2.1.3. Educational Status

To analyze the response of farmers by education, household heads were divided into four as illiterate, read and write primary education and secondary education (Table 8). The majority of both non-adopter (53.1%) and adopters (42.6%) are illiterate. Out of 57.4% adopters of SWC measures 29.4% of households could read and write, 19.1% had primary education, and only 8.8% had secondary education while out of 64.9% literate non-adopters of SWC measures 21.6%

of households could read and write, and 32.4% and 10.8% of households had primary and secondary education respectively.

For detail analysis, household heads were categorized into two as illiterate and literate by combining read and write, primary education and secondary education as literate. The survey result showed, 60% of the sample household heads were literate, while 40% were illiterate.

Table 8. Educational status of sampled household heads

Educational status of the household head	Level of adoption of SWC measures				Total		X^2 Statistics
	Non-adopter		Adopter				
	N	%	N	%	N	%	
Illiterate	13	53.1	29	42.6	42	40	
Read and Write	8	21.6	20	29.4	28	26.7	
Primary Education	12	32.4	13	19.1	25	23.8	
Secondary Education	4	10.8	6	8.8	10	9.5	
Total	37	100	68	100.	105	100	2.767(ns)
Educational status by category							
Illiterate	13	35.1	29	42.6	42	40	
Literate	24	64.9	39	57.4	63	60	0.563(ns)
Total	37	100	68	100.	105	100	

Source: Own survey, 2009; Note: (ns), not significant.

The chi-square result revealed no systematic association between educational status of households and adoption of soil and water conservation measures of the sampled household heads (Table 8).

5.2.1.4. Family Size

With regard to number of family members, the largest family size is 11 and the smallest is 1. The examination of farmers' adoption of conservation structures by dividing family size into groups showed less difference by household size. Farmers that adopt SWC structures (82.4%) and not adopt conservation structures (73%) have family size of 5-7 people. The percentage of both group of farmers showed a decreasing pattern with increasing household size. The chi-square test shows that there no systematic relation ship between family size category of the households and adoption of soil and water conservation.

The mean family size of the sample households, non-adopters and adopters of SWC measures were 6.15, 5.92, and 6.28 persons with a standard deviation of 1.385, 1.341 and 1.402 respectively. The t-statistics shows there is no significant mean difference between the two groups in family sizes.

Table 9. Distribution of household size of sampled households

Household Size Category	**Level of adoption of SWC measures**						
	Non-adopters		**Adopters**		**Total**		
	N	%	N	%	N	%	**X^2 Statistics**
1-4	6	16.2	5	7.4	11	10.5	
5-7	27	73	56	82.4	83	79	
8-11	4	10.8	7	10.3	11	10.5	2.070(ns)
Total	37	100	68	100	105	100	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**t- Statistics**
Total Household Size	5.92	1.341	6.28	1.402	6.15	1.385	1.278(ns)

Source: Own survey, 2009; Note: (ns), not significant.

The average number of active agricultural workers (15-64) is 2.135 and 2.867 for non-adopters and adopters respectively. The average number of children (<14 years) was 3.027 and 3.411 for non-adopters and adopters respectively. But, with focus group discussion of farmers of the study area, children with the age of 10 years and above can do and participate in different farming activities like plowing, weeding, keeping livestock in near grazing lands.

Table 10. Distribution of family members of sampled households by age

Family members by age	Average family size of		
	Non-adopters	Adopters	Total samples
Children < 14 years	3.027	3.411	3.276
Family members 15-64	2.135	2.867	2.609
Family members >64	-	1.00	1.00
Average family size	5.92	6.28	6.15

Source: Own survey, 2009.

5.2.1.5. Farm Experience

Farm experience is the number of years the household involved in farming as a means of living. The average years of farm experience were 24.2, 16.16 and 28.57 for sampled household heads, non-adopters and adopters of SWC technologies respectively. The range of experience lies between 5 and 60 years and the most frequent years of experiences are found between 5 and 35 years (Table 11).

The chi-square test shows that there is a strong systematic relationship between farm experience of the households and adoption of soil and water conservation. With longer experience in farming, knowledge, skills, and attitudes are gained on the agricultural operation including soil and water conservation practices. So, farmers with longer experience are less conservative and convinced. It is more likely that farmers with longer farming experience will be ready to accept changes and adopt new ideas and techniques for the increase of production on their farm including soil and water conservation measures.

The mean farm experience of the non-adopters and adopters of SWC technologies were 16.16 and 28.57 years respectively. Under the socio-economic condition of the study area experience in farming is related with adoption of soil and water conservation and a significant mean difference was observed in farm experience between the two groups.

Table 11. Distribution of sampled households by farm experience

Farm experience of household heads	Non-adopters		Adopters		Total		X^2 Statistics
	N	%	N	%	N	%	
5-15	24	24.9	10	14.7	34	32.4	
16-25	7	18.9	24	35.3	31	29.5	
26-35	5	13.5	12	17.6	17	16.2	
36-45	1	2.7	16	23.5	17	16.2	
46-60	0	0	6	8.8	6	5.7	
Total	37	100	68	100	105	100	30.731***
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**t-Statistics**
Farm experience of household head in years	16.16	11.40	28.57	8.02	24.20	11.9	5.867***

Source: Own survey, 2009; Note: *, significant at 1%.**

5.2.1.6. Labor Availability

In the study area, farmers mainly depend on family labor for their farm activities and social purposes. The total size of labor is computed by converting the available labor in the household into man equivalent index (see appendix 1). The mean total labor in man equivalent of the sample households was found 2.39 with standard deviation of 0.86. The mean labor of non-adopter and adopter households was 2.36 and 2.46 with standard deviation of 0.85 and 0.89 respectively (Table 12). As the result indicates, adopter households relatively have more family labor than non-adopter households. The statistical analysis showed no significant mean difference between the two groups in their total labor size.

Although most farmers have small land holdings, they face labor shortage for some critical farm seasons. These critical seasons /activities include, mainly, weeding and harvesting of crops like, *teff*, wheat, barely and bean. Out of the total sample households, 50.5% reported shortage of labor to perform farming activity, of which 45.9% and 52.9% were from non-adopter of SWC measures and adopter of SWC measures groups respectively (Table 12).

Table 12. Labor characteristics of the sampled households

	Level of adoption of SWC measures						X^2 Statistics
	Non-adopters		**adopters**		**Total**		
	N	%	N	%	N	%	
Do you face any labor shortage last year for your farm activity?							
No	20	54.1	32	47.1	52	49.5	
Yes	17	45.9	36	52.9	53	50.5	
Total	37	100	68	100	105	100	0.469(ns)
Mechanisms used for solving labor shortage problem?							
Hired labor	13	68.4	7	22.6	20	40	
Traditional labor arrangement (*debo/wonfel/debayt/webera*)	6	31.6	20	64.5	26	52	
Both	0	0	2	6.5	2	4	
None/other mechanism	0	0	2	6.5	2	4	
Total	19	100	31	100	50	100	11.098**
	Non-adopters		**Adopters**		**Total**		**t- statistics**
	Mean	**SD**	**Mea n**	**SD**	**Mean**	**SD**	0.616(ns)
Total household labor	2.36	0.87	2.46	0.89	2.39	0.87	

Source: Own survey, 2009; Note: (ns), not significant; **, significant at 5%.

It seems adopter of SWC measures households experience more labor shortage for farm activities than non-adopter of SWC measures households. The chi-square result revealed there is no systematic relation between labor shortage problem and adoption of SWC measures of the sampled household heads.

To tackle the problem of labor shortage farmers of the area have an inherited age-old labor sharing arrangements which are also common in other parts of the country. Thus, the popular way of overcoming labor shortage especially for the major labor demanding agricultural tasks is use of the traditional mutual labor exchange arrangements namely *Debayt/debo/wonfel and Wobera*, which were reported by the majority of the sampled households (52%) (Table 12).

Wonfel/Debo/Debayt is a reciprocal labor sharing arrangements which farmers help each other at times of peak labor demanding seasons *Wobera*, on the other hand, is an arrangement, which is practiced mostly by rich and middle class farmers who rent in others crop land and cultivate more than the average land holding, whereby the host farmer is expected to serve foods and drinks for the assisting farmers. In this case reciprocity is not expected. Conversely, farmers who are unable to cultivate their land, mostly, due to oxen unavailability or seed shortage or landlessness are employed as casual laborer for peak farming activities. Most female headed and few rich households engage in use of this arrangement. The wage for labor varies between 3 to 8 birr per day depending on the season. In bad season, when there is drought and food shortage, wage goes as low as three birr per day and goes up in good seasons. Similarly, 40% of sample households hired available labor to tackle their labor shortage, comprising 68.4% of non-adopter and 22.6% of adopter of SWC measures.

Hence, SWC activities are labor intensive, traditional labor arrangements were not used and instead family labor was used dominantly for the constructions and maintenances of SWC measures.

5.2.1.7. Off-farm Activities

One of the major interest of the study was to investigate if there is any relationship between farmers' adoption of SWC structures and having other sources of income.

According to the survey result, out of the total sample household heads 52.4% reported involvement in off farm income generating activities. The non-adopter of SWC measures households (67.6%) were found performing off-farm activities than adopter of SWC measures (44.1%) households that show the existence of more opportunity and the significant contribution of income from off-farm activities. The chi-square shows there is systematic relationship between adoption of soil water conservation measures and involvement in off farm activities at 1% significance level (Table 13). This means that farmers who participate in off-farm activities don't perform SWC activities in their land because of their interest in off-farm income for their livelihood.

Table 13. Off farm activity of the sampled households

Do you involve in off farm activity	Level of adoption of SWC measures						X^2 Statistics
	Non Adopters		Adopters		Total		
	N	%	N	%	N	%	
Yes	25	67.6	30	44.1	55	52.4	
No	12	32.4	38	55.9	50	47.6	
Total	37	100	68	100	105	100.0%	-5.283***
Types of off farm work							
Handicraft	2	8	4	10.8	6	9.7	
Daily laborer	17	68	11	39.3	28	45.2	
Selling firewood and/or poles of eucalyptus	6	24	22	59.5	28	45.2	9.114**

Source: Own survey, 2009; Note: *, significant at 1%; **, significant at 5%.**

In the study area, the most common off-farm activities are daily laborer, selling of fire wood and poles of eucalyptus in near by towns and handicraft making. Due to very limited income and return obtained from these activities, most farmers do not consider off-farm income as a primary income source; therefore it has a supplementary role. The scope to diversify their cash income through employment in off-farm activities appears very limited.

5.2.1.8. Land Ownership and Size of Land

Farm size and ownership are the two critical rural livelihoods issue for farmers in general in Ethiopia and Meket *woreda* in particular. Farmers who own larger and fertile farmland are richer, in relative terms, than those who have less and infertile farmland. As land is a public property owned by the government, farmers have only usufructuary right to the plots of farmland they are entitled to. The majority of farmers own equal or less than 0.5ha of farmland (54.3%) as well as farmers who own a farmland between 0.51-1 ha make 37.1% of the sample households. The majority of those farmers who own less than 0.5 ha in the area are young (i.e with age group between 21 and 41), since no redistribution of farmlands was made after 1993. Hence, the young generation own very small plots that got very small land from their family. However, at present, younger farmers who have not before are getting very small plots of land from the *kebele* administration by taking the lands of passed away farmers and the migrant farmers who leave their land.

The size of farmland owned per household has been shrinking since so long due to the ever increasing human population. The majority of the sample households (91.4%) have less than one hectare. The chi-square test shows that there is no systematic relationship between farm land size of the households and adoption of soil and water conservation measures.

Table 14. Distribution of sampled households by mean land size

Land size (ha)	Level of adoption of SWC measures						X^2 Statistics
	Non-adopters		Adopters		Total		
	N	%	N	%	N	%	
0.1-0.5	18	48.6	39	57.4	57	54.3	
0.51-1	17	45.9	22	32.4	39	37.1	
1.1-1.5	2	5.4	7	10.3	9	8.6	
Total	37	100	68	100	105	100	2.195(ns)

Source: Own survey, 2009; Note: (ns), not significant.

The survey result showed that the mean land size holding of total sample households, non-adopters and adopters of SWC measures were 0.63, 0.61 and 0.65 hectares with a SD of 0.211, 0.191, and 0.221 of land respectively. There is no significant mean difference between adopter and non-adopter of soil and water conservation measures of households.

Table 15. Mean size of owned, shared in and shared out land

Types of land	Level of adoption of SWC measures						t-Statistics
	Non-adopter		Adopter		Total		
	Mean	SD	Mean	SD	Mean	SD	
Size of owned land	0.61	0.191	0.65	0.221	0.63	0.211	0.895(ns)
Size of shared in land	0.44	0.124	0.43	0.226	0.44	0.193	0.193(ns)
Size of shared out land	0.22	0.129	0.23	0.053	0.22	0.092	0.140(ns)

Source: Own survey, 2009; Note: (ns), not significant.

5.2.1.9. Livestock Production

In addition to crop production, livestock rearing is the other major agricultural activity undertaken predominantly in the study area. The main livestock types that are generally kept to make-up the livestock resources of Meket *woreda* include cattle, goats, sheep, donkeys, horses and mules. Livestock are maintained in the study area for draught, milk, meat, egg, and mainly for sale purposes and generally considered as a productive asset for the household. The average numbers of livestock holding between the two groups of sampled households have some difference. In order to make comparison of the herd size between the sampled household groups, the herd size was converted into Tropical Livestock Units (TLU) based on Storck *et al.* (1991), (see Appendix 2).

Table 16. Livestock ownership by sampled farmers

Livestock ownership in TLU	Level of adoption of SWC measures				t-statistics
	Non-adopters		Adopters		
	Mean	S.D	Mean	S.D	
Oxen	1.1162	0.5823	1.2765	0.4977	1.483(ns)
Cows	0.548	0.476	0.713	0.476	1.669(ns)
Heifers and calves	0.454	0.411	0.617	0.547	1.587(ns)
Goats	0.473	0.159	0.382	0.115	1.281(ns)
Sheep	0.482	0.417	0.577	0.508	1.184(ns)
Donkeys	0.432	0.292	0.595	0.398	2.189*
Mules	0.0000	0.00000	0.353	0.165	1.294(ns)
Horse	0.4541	0.6938	0.5882	0.6717	0.967(ns)
Total	3.7757	2.1428	4.4794	2.4497	3.014**

Source: Own survey, 2009; Note: *, significant at 5%; (ns), not significant.

Moreover, diversified livestock holding is the prime strategy in all the cases that farmers traditionally practice to minimize the risk of vulnerability to drought that repeatedly occurs in the area. Keeping of various livestock species together serves as a good buffering strategy to cope up crop failure that occurs very repeatedly in the area. Hence, the mean herd size in Total Livestock Unit (TLU) for the adopter of SWC measures were slightly greater than that of non-adopter of SWC measures which were 4.4794 and 3.7757 respectively. The independent sample t test for the means difference was significant at 5% (Table 16). Small ruminant sheep and goats are reared and served as a readily source of cash for farm households during food shortage seasons.

Adopter of SWC measures households actually own relatively high numbers of pack animals (mules, donkeys and horses) than non-adopter of SWC measures as it is indicated Table 16.

5.2.1.10. Soil Erosion Problem Perception

Meket *woreda* is one of historically known parts of Ethiopia by the long history of human settlement. Agriculture is continuing to be the base of the livelihood for centuries. Because of long years of agricultural practice and the rugged nature of the topography, soil erosion played an important role for the current degraded situation of the agricultural land in the study area.

Farmers were asked the perception of soil erosion problem on their farmland and its trend over time (Table 17).

Table 17. Farmers' perception towards problem of soil erosion

	Non-adopters		Adopters		Total		X^2-Statistics
	N	%	N	%	N	%	
Do you perceive soil erosion as a problem in your farmland?							
Yes	25	67.6	68	100	93	88.6	
No	12	32.4	0	0	12	11.4	
Total	37	100	68	100	105	100	24.900***
What is trend of soil erosion over years?							
Increasing	3	8.1	8	11.8	11	10.5	
Decreasing	10	27	39	57.4	49	46.7	
No Change	24	64.9	21	30.9	45	42.9	
Total	37	100	68	100	105	100	11.485**

Source: Own Survey, 2009; Note: **, significant at 5%; *, significant at 1%.**

Based on farmers response, soil erosion is one of the major problem that reduce land productivity and food shortage in the area. Assessment of farmers' adoption of conservation structures by level of perception of erosion as a problem revealed that farmer that perceived erosion problem on his farmland may did some SWC measures.

Majority of the sampled farm households (88.6%) perceived soil erosion as a problem on their cultivated land. Among farmers that adopt SWC structures on their farmland, 100% of the respondents perceived soil erosion as problem on their farm land. However, large number of farmers (67.6%) who don't adopt SWC structures perceived soil erosion as a problem. This supports the findings of Woldeamlak (2003). According to him, perception of soil erosion as a problem with economic significance is not sufficient condition for the adoption of soil and water conservation measures though it is a necessary condition.

The chi square result showed that there is significant relationship with the adoption of SWC and soil erosion problem perception (Table 17).

Farmers were asked to indicate the rate of erosion over years in their farm land. Out of the total sampled households, 46.7% of the interviewees rated erosion has decreasing trend; 10.5% rated erosion has increasing trend and 42.9% respond no change.

Considering the responses given by the two groups, a larger proportion of the non-adopter of SWC households (64.9%) responded that there has no change in trend and 27% reported the trend of soil erosion over time is decreasing on their farm land as well as the remaining 8.1% responded the increasing trend of soil erosion over time. With regard to adopter of SWC measures, the majority (57.1%) replied there is a decreasing trend of soil erosion and 30.9% farmers responded that there is no change at all pertaining to the trend of soil erosion over time (Table 17). This can be due to the positive outcomes of soil and water conservation measures taken to the problem of soil erosion by households. The chi-square result shows that there exist a significant association between the trends of erosion on farmers' field and adoption of soil and water conservation structures.

5.2.1.11. Causes of Soil Erosion

There are various interacting forces, which have caused and are causing soil erosion in the area. Many argue that, human activities combined with adverse climatic conditions have played as factors of soil erosion and consequent land degradation. In line with this, both groups in the study ranked that, high rainfall during summer season (27%), limited and weak SWC measures (24%), continues cultivation (21%) and cultivation of steep and very steep slopes (16%) ranked as 1^{st}, 2^{nd}, 3^{rd} and $4^{th\ major}$ causes of soil erosion in the area (Table 18).

Table 18. Causes of soil erosion according to the sampled households

Causes of soil erosion	Level of adoption of SWC measures				Total	
	Non-adopters		Adopters			
	N	%	N	%	N	%
High rainfall during summer	23	27	62	28	85	27
Limited and weak SWC measures	18	21	57	26	75	24
Continues cultivation	21	25	46	21	67	21
Cultivation of steep slopes	13	15	37	17	50	16
Over grazing	10	12	17	8	37	12
Total*	85	100	219	100	314	100.0

Source own survey, 2009; Note: *, percentages and totals are based on multiple responses.

5.2.1.12. Consequences of Soil Erosion

Soil erosion causes a reduction in infiltration and the water holding capacity of the soil as well as a loss of plant nutrients which ultimately results reduction in productivity. Accordingly, farmers in both groups prioritize that crop productivity decline as first consequence of soil erosion (31%) followed by loss of soil fertility (29%) and farmland out of cultivation (25%) as second and third consequence of soil erosion in the study area. (Table 19).

Table 19. Consequences of soil erosion according to the sampled households

Consequence of soil erosion	Level of adoption of SWC measures				Total	
	Non-adopters		Adopters			
	N	%	N	%	N	%
Low crop production	32	36.5	63	29	95	31
Loss of soil fertility	27	30.5	61	28	88	29
Farmland out of cultivation	18	20.5	56	26	74	25
Livestock feed shortage	11	12.5	35	17	46	15
Total*	88	100	215	100	303	100

Source: Own Survey, 2009; Note: *, multiple response analysis.

5.2.2. Institutional Characteristics of the Sampled Households

5.2.2.1. Land Security

Perception on land security is one of the determining factors for farmers' to take risk and invest on their farm land either by adopting different inputs and technologies or their labor on land conservation measures that can directly or indirectly increase productivity of land and eventually improve their food security status. Thus, the sample household heads were asked whether they perceive a risk of loss of their plot of land in the future through land redistribution and majority (93%) of the households do not anticipate loss of their farm plots in the future and only (11.4%) feel loss of their farm land in the future (Table 20). This is probably due to the recent development in providing farmers use right of land certificate which has contributed positively to feelings of land security. The chi-square result showed no significant relationship between land security and adoption of soil and water conservation measures.

Table 20. Perception about land security of sampled households

	Non-adopters		Adopters		Total		
	N	%	N	%	N	%	X^2 Statistics
Do you fell that you will loss your farmlands in the future?							
Yes	2	5.5	10	14.7	12	11.4	2.048(ns)
No	35	94.6	58	85.6	93	88.6	
Total	37	100.0	68	100.0	105	100	

Source: Own survey, 2009; Note: (ns), not significant.

Land tenure has important implications in agricultural development in general and natural resources conservation in particular. The Amhara National Regional state issued a proclamation to determine the administration and use of rural land in 2000. The current registration and distribution of land use certificate given to land holders serves a good starting point to focus on the rural land problem. In the Amhara National Regional State (ANRS) in general and Meket *Woreda* where this study was undertaken in particular has been a very common apparent fact. In the study area, respondents revealed that they have passed through different redistributions since the previous regime and indicated the last one undertaken in 1993.

5.2.2.2. Access to Extension Service

In the study area, the most important sources of information are the government mainstream agricultural extension program, information obtained from relatives and neighbors, model farmers and non-governmental organizations. Farmers' pointed out that governments' extension service is the most important source of information. Extension service is provided by extension workers of the government and to some extent by experts of non-governmental organizations. Three development agents who are graduated at a diploma level in the fields of natural resources conservation, plant science and animal science are assigned at each Farmers Training Center (FTC) in each *kebeles* to give frequent and continuous technical support and advice for farmers.

Extension agents/Development agents contact farmers on an individual basis, though farmers who have suitable plots in adjacent locations are teamed up for demonstration. About 70.5% of the sample households responded that they were visited by development agents at least 2-3 times in a month on average. The chi-square test also shows there is significant relationship between access to extension service given by development agents and adoption of soil and water conservation measures at 1% significance level (Table 21).

Table 21. Distribution of sampled households by access to extension service

	Non-adopters		Adopters		Total		X^2Statistics
	N	%	N	%	N	%	
Visit by the Development Agent							
Yes	15	40.5	59	86.8	74	70.5	
No	22	59.5	9	13.2	31	29.5	
Total	37	100	68	100	105	100	24.606***
Training in soil and water conservation							
Yes	3	8.1	41	60.3	44	41.9	
No	34	91.9	27	39.7	61	58.1	
Total	37	100	68	100	105	100	26.806***

Source: Own survey, 2009; Note: *, significant at 1%.**

As a result, extension service given by development agents through repeated field visits and trainings in relation to SWC activities play pivotal role for the adoption of SWC measures.

5.3. Determinants of Adoption of Soil and Water Conservation Measures

A logit model was applied to estimate the effect of the hypothesized explanatory variables on the probabilities of adoption of soil and water conservation practices looking closely in to the relation of dependent variable to the explanatory variables for a household who has either adopted them or not. Adoption of soil and water conservation practices acted as a dichotomous dependent variable representing 1 as adoption of soil and water conservation practices and 0 otherwise. Multicollinearity diagnostics test was done to check the presence of high colinearity among and between each independent variable. Different methods were employed to check the presence of multicollinearity for continuous and discrete explanatory variables. Variance Inflating Factor (VIF) was used to check for multicollinearity problem among and between continuous variables and for discrete variables coefficient of contingency (CC) was computed using SPSS software.

For this case, based on the results of the diagnostic tests for continuous variables, age and farm experience were found to be highly correlated and associated with one an other and age of household head was excluded from the analysis (Appendix 3 and 4).

As a result, ten variables were hypothesized to have an effect on the adoption of soil and water conservation structures and were entered to the model using version 15.0 SPSS computer software.

Out of the variables analyzed, the coefficients of four variables, namely farmers' perception of soil erosion as problem, farmers experience in farming activity, extension service and involvement in off farm activities were significantly different from zero and found to be significant to affect the adoption of soil and water conservation measures in the study area. The remaining variables have no significant relationship with the adoption of soil and water conservation measures in the study area.

Among the factors that significantly affect the adoption of soil and water conservation measures in the study area, farmers' perception towards soil erosion, farmers experience in farming activity and extension services given by development agents have positive and significant influence on the decision to adopt SWC structures. On the other hand, participation in off farm activities has a negative and significant influence on the adoption of soil and water conservation measures.

5.3.1. Discussion on Significant Explanatory Variables

Perception of soil erosion as a problem (PERCEP)**:** Perception of soil erosion as a problem was significantly and positively associated with adoption of soil and water conservation structures on cultivated owned land. This implies that the better the farmers perceive the problem of soil erosion, the more likely the farmers to adopt soil conservation structures on their lands. The odds ratio of 60.20 implies that the possibility of a farmer, who perceived soil erosion better to adopt SWC structures is 60.720 times the odds of the farmers that did not perceive would be (Table 24). It affects the decision of farmers by shaping opinion of farmers with regard to the conservation of resources.

This finding is in accordance with the results of (Girmachew, 2005; Kumela, 2007) that perception of soil erosion problems is positively and strongly associated with farmers' willingness to adopt soil conservation structures. According to these studies farmers' perception towards soil erosion problem is the first step in the adoption process and has positive impacts on farmers' adoption decision. This result implies that it is not only the capability of the farmers but also their perception of the damaging effects of soil erosion that influence the decision to participate in soil and water conservation practices.

Thus, perception of soil erosion as a problem is a necessary condition for adoption of soil and water conservation technologies.

Table 22. The maximum likelihood estimates of the binary logit model

Explanatory variables	Estimated coefficient (B)	Odds ratio Exp(B)	Significance level	Standard error (S.E.)
SEX	1.832	6.247	0.299	2.697
EDULHH	-1.805	0.164	0.497	1.739
FAMSIZE	0.173	1.189	0.654	0.386
FARMSIZE	2.768	15.934	0.144	1.894
FARMEXPER	0.212	1.236	0.071*	0.117
OFFARM	-3.333	0.036	0.045**	1.661
PERCEP	4.106	60.720	0. 009***	1.565
TLU	-0.063	0.939	0.828	0.289
EXTEN	2.894	18.066	0. 036**	1.380
LASECURIT	-0.845	0.429	0.682	2.066
Constant	-8.218	0.000	0.018**	3.459

Pearson chi-square	95.294***
-2 log likelihood	40.977
Sample size	105
Correctly predicted adopters	91.2
Correctly predicted non-adopters	83.8
Overall prediction	88.6

*, **, *** Indicate significance at 10%, 5% and 1% level respectively.

Source: Model output, 2009.

Farm experience (FARMEXPER): The result indicated that farm experience of household head positively associated with the probability of adoption of improved SWC technology at less than 10% significant level. An increase in the number of years of the household's farm experience increases the decision on practicing soil and water conservation practices. The implication is that farmers who have more years of farm experience are more likely to adopt soil and water conservation structures than those farmers who have less years of farm experience. Farmers with longer experience in farming have often more information and better knowledge and able to evaluate the advantage of the technology.

As a result, longer experience in farming have developed better knowledge, attitude and skill on the operation and conduct of agricultural activities and methods of production, which facilitates acceptance of changes and adopt new ideas and techniques. The odds ratio in favor of practicing soil and water conservation practices increases by a factor of 1.236 for an increase in farm experience implies that farmers who have longer experience in farming activities to adopt SWC structures is 1.236 times the odds of shorter experience in farming activities (Table 22). Older farmers have better knowledge and attitude towards the benefit of SWC measures through their life experience of the decrease of their land productivity from time to time and thus are more likely to invest in soil and water conservation measures.

Extension service (EXTEN): It represents the access of information, assistance and visit to the farmers by the development agents per year. Increasing the number of visits made by the development agents have positive relation with the adoption of soil and water conservation practices which results from accelerated effective dissemination of soil and water conservation information to the farmers. Visits by the development agents such as village level training, village tours, information from mass media and participation in conservation planning enhance the level of investment in soil and water conservation significantly. Other things held constant, the odds ratio in favor of decision on soil and water conservation practices increases by a factor of 18.066 for a unit increase of extension service by the development agent (Table 22).

Involvement in off-farm activities (OFFARM)**:** The model result confirmed that involvement in off-farm activities significantly determine the adoption of soil and water conservation activities in the study area. An increase involvement in off-farm activities decreases the decision on practicing soil and water conservation structures. The negative sign of estimated coefficient shows a negative relation with adoption of soil and water conservation structures and the odds ratio is incompatible of being the probability of the adoption of conservation structures, *ceteris paribus,* decreased with factor of 0.036 with household not applying soil conservation measures (Table 22)

A study conducted by Abera (2003) in Farta *Woreda* of Northern Ethiopia revealed that increasing involvement in off-farm activities for income generations decreases the participation of farmers towards soil and water conservation activities. Consistent with this finding, the variable off-farm involvement had a negative and significant effect on the probability of adopting soil and water conservation structures. Off-farm activities in the slack season overlap with time of construction and maintenance of soil and water conservation structures.

As a result, farmers who involve in off-farm income generating activities are likely to put less effort in maintenance and construction and hence on adoption of improved SWC structures.

6. SUMMARY AND CONCLUSIONS

6.1. Summary

At present, Ethiopia is facing greater natural resource depletion in general and soil erosion in particular. Especially the problem is extremely serious and widespread in the highlands of Ethiopia including the study area. The study was carried out in the Amhara Region of North Wollo Zone, Meket *Woreda.*

The specific objectives of this study were to describe the current soil and water conservation practices undertaken in the study area and to identify and assess the demographic, socio-economic and institutional determinants of soil and water conservation structures adoption.

Data collection took place in two phases. The first phase involved collection of general information about the study area including review of secondary information from various publications and reports, informal discussions with key informants, individual heads of households and groups of heads of households. The second phase concerned with household head level data collection using a structured questionnaire. The total sample sizes of the survey were 105 households; out of which 64.8% were adopter and 35.2% are non-adopters of SWC structures.

The data analysis was carried out using descriptive statistics and binary logit model. The main soil and water conservation activities practiced in the study area are done at individual household heads levels as well as at communal land levels. The main introduced SWC structures implemented on individual farmlands are soil bunds, stone bunds and stone faced soil bunds; while the area closure, hillside terraces and check dams are the most common structures practiced at communal farmlands. In addition to these, farmers of the study area also practiced indigenous

SWC practices which includes traditional ditches (*boyi*), grass strip (*dib/weber*) and contour plowing (*agdem mares*).

The binary logit model was used to estimate the effects of the independent variables on the probability of the heads of the households to adopt introduced soil and water conservation measures.

Adopters and non-adopters of SWC structures differed in some demographic, socio-economic and institutional variables; such as family size, farm experience, labor availability, farm size, extension visit and total livestock between the two groups, which imply the differences in their soil and water conservation practices adoption behaviors.

A total of 10 variables were fitted in the logit model. Among these, farm experience, extension service, farmers' perception of soil erosion as a problem and involvement in off-farm activities are statistically significantly related to adoption of soil and water conservation practices by the farmers. On the other hand, the coefficients of the variables such as sex, educational level of the household, family size, farm size, the total livestock unit and land security or security of tenure are not statistically significantly related at conventional level of probability.

6.2. Conclusions and Recommendations

Even though farmers are trying to conserve their lands from soil erosion hazards, it is still pervasive problem in the study area. Both indigenous and modern soil and water conservation technologies are practiced by farmers on individual farm lands as well as communal lands. The main soil and water conservation structures practiced are physical in nature and some agronomic measures are also practiced. The most common physical structures undertaken are soil bunds, stone bunds, soil-stone bunds, check dam, hill side terraces while the agronomic practices includes area closure, traditional ditches, contour plowing, grass strips.

In this study, analysis was also made to identify the demographic, socio-economic and institutional attributes of soil and water conservation technologies that influence farmers' decision on practicing the technologies which is necessary and pivotal for the adoption of soil and water conservation structures.

Extension services that enhance farmers' understanding on soil degradation process play a decisive role in the promotion of technologies related to SWC. This was indicated by significant differences between adopters and non-adopters compared in this study.

Even though farmers are exposed to the same bio-physical environment, their understanding of the process and subsequent actions of soil erosion may vary. In this study, it was found that farmers who perceived the problem of soil erosion positively responded to soil and water conservation activities unlike those who felt otherwise.

Involvements in off-farm activities are the most significant factor that influences farmers' decision to adopt conservation structures negatively. This is due to the fact that farmers who are involved in off-farm activities are in need of more income for home consumption, to buy the family clothes and to get profit for future consumption in their slack season. Hence, involvement in off-farm income generating activities participation hinders the constructions and maintenances of SWC structures.

The results of the study have shown that the socio-economic and institutional characteristics of the sample household heads are the responsible factors for the decision of farmers' to use soil and water conservation strategies. Hence, development policy and program intervention designed to enhance agricultural productivity through promoting soil and water conservation strategies of land management in the study area need to take into account these most important variables with respect to the type of innovation and farmers preference. More specifically, based on the results of this finding the following recommendations are forwarded:

1. **Strengthening awareness creation on soil erosion problems**

The result of the study showed that individual farmers have his/her own perception in evaluating the problem, causes and consequences of soil erosion. Farmers' perception on soil erosion problem, causes and consequences should get due attention by development agents and agricultural extension program and should focus on awareness creation of the soil erosion hazards for farmers.

Therefore, even though extension system on land management specifically SWC activities are widely diffused through development agents and other concerned individuals, consistent efforts at the grass root level is very important to minimize and stop soil erosion on farmers plot by improving farmers' consideration of the state and end results of soil erosion to their livelihoods including the future generation.

2. **Strengthening Agricultural Extension Services**

The result of the study showed that access to extension service is a very important variable that positively and significantly influenced the adoption of soil and water conservation strategy.

Therefore, to sustain the positive contribution of the extension service to the adoption of soil and water conservation structures, extension services on conservation strategies of land managements especially SWC strategy should strengthen its endeavors in promoting sustainable agriculture with a due recognition of differences among farmers in their understanding of the soil erosion symptoms and soil and water conservation structures at the grass root level. Village and community level training is very crucial for young and less experienced farmers in order to have better awareness towards the problem of soil erosion and the role of SWC measures and hence invest their time and labor in constructing and maintaining soil and water conservation measures.

And thus, extension services should get more due attention and strengthened by both development agents and other NGos who invest their time and resources in natural conservation activities specifically in soil and water conservation activities for the development of agriculture in the country.

3. **Giving due attention for the complementarities of off-farm activities and SWC practices**

The study revealed that off-farm activities have a significant and negative correlation with the adoption of soil and water conservation strategies.

Agricultural sector has to be made productive and attractive so that farmers can invest and decide more on conservation structures. And this require making the agricultural sector more productive by applying the introduced technologies and providing the required infrastructures for the development of market such that farmers can get full benefit of they produce.

Thus, there is a need that extension planners should give attention to activities, which focuses on the complementarities of both the conservation strategies of soil and water conservation activities and income generating activities.

In general a flexible integrated rural development program is an urgent need to extend the concept of soil and water conservation. Soil and water conservation should be an integral part of soil fertility management, agronomic practices, rain water harvesting, fodder production, vegetation cover and fuel wood production at village and community levels.

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8. APPENDICES

Appendix 1. Conversion factors used in estimation of man-equivalent (ME)

Age Group	Male	Female
< 10	0	0
10-14	0.35	0.35
15-50	1	0.80
> 50	0.55	0.50

Source: Storck, et al. (1991)

Appendix 2. Conversion factors used in estimation of tropical livestock unit (TLU)

Livestock	Average Biomass (Kg)	TLU Equivalent
Camels	250	1
Cattle	175	0.7
Sheep/Goat	25	0.1
Horses/Mules	200	0.8
Donkeys	125	0.5

Source: ILCA (1990)

Appendix 3. Variance Inflation Factors (VIF) of Continuous variables

Variables	R_j^2	VIF(x_j)
Farm exper in years	0.589	1.70
Family size	0.683	1.47
TLU	0.772	1.30
Size of owned land	0.973	1.03

Source: own computation, 2009

Appendix 4. Contingency Coefficients for Discrete Explanatory Variables

	SEX	EDU	OFFFARM	EROPER	EXTEN	LASEC
SEX	1	0.256	0.013	0.220	0.037	0.116
EDU		1	0.016	0.086	0.221	0.169
OFFFARM			1	0.151	0.292	0.059
EROPER				1	0.048	0.028
EXTEN					1	0.091
LASECU						1

Source: Model output

Appendix 5. Household Heads Questionnaire

A. Household characteristics

1. Name of the household head…………………..........
2. Sex 1) male……...2) female……………………
3. Age ……….in years.
4. Religion 1) Orthodox 2) Muslim 3) Others
5. Marital status 1) married 2) single 3) divorced 4) widowed
6. Social status 1) religious leader 2) political leader 3) political member 4) others
7. Level of education of the household head 1) illiterate 2) read and write 3) primary School 4) secondary school 5) others…………..
8. Farm experience of the household heads in years………..

9. Household family size with age and sex

Family members	Sex		Total
	Male	female	
Children< or =10 years			
Between 11-14 years			
Adults 15-60 years			
More than 60 years			

B. Labor availability

10. Do you have enough labor to perform all the farm work?

    1) Yes 2) No

11. For which agricultural activities do you demand more labor?

    1) tilling/plowing 2) weeding 3) harvesting 4) SWC activities

12. If you have labor shortage, how do you solve it?

    1) By hiring 2) using daily laborers 3) cooperation *(debo/wenfel/webera)* 4) using relatives

13. If you use hired labor, what type of labor do you hire?

    1) Causal 2) permanent 3) both 4) others specify………..

14. Can you get labor when you need? 1) Yes 2) No

15. On which farm activities do your female family members participate?

    1) Weeding 2) collecting crops and crop residues 3) in SWC activities

16. Which family members participate in SWC activities?

    1) Men 2) women 3) children 4) all

17. Do your family members work on off farm activities? 1) Yes 2) No

18. If yes for Q (17) in which of the following activities do you participate?

    1) Handicraft 2) laborer 3) petty trading 4) selling of fire wood 5) others, specify......

C. Livestock production

19. Do you participate in animal husbandry? 1) Yes 2) No

20. If yes, for No (19) fill the following table

Animal type	Total number
Oxen	
Cows	
Heifers	
Mules	
Horses	
Donkeys	
Goatees	
Sheep	
Others specify	

21. How is the present number of your animal as compared to the previous years?

    1) Increasing 2) decreasing 3) remain the same

22. What is/are the main source/s of feed for your animals?

    1) Grazing 2) hay 3) crop residue 4) others, specify……..

23. Is there feed shortage for your animals 1) yes 2) no

24. If yes for Q (23), what is/are the causes of shortage/s?

    1) Expansion of cropland 2) degradation of lands 3) expansion of settlements 4) others, specify………

25. What are the major livestock constraints in your area? Fill the table

Livestock production constraints	Rank
Repeated drought	
Animal disease	
Feed shortage	
Lack of improved feeds	
Others	

26. What should be done to solve the problem of feed shortage?

1) Collecting straw, hay from the field 2) conserving '*dib/weber*'/fallow the land

3) Producing fodder crops on fallow lands 4) reducing the number of animals

5) Others specify.........

D. Land ownership/ farm size

27. Do you have your own agricultural land? 1) Yes 2) no

28. If yes for Q (27), what is the total size of cultivable land in hectare/"timad"?...............

Type of land use	Size in hectares/timad
Cultivated land including irrigation land	
Rented in land/shared in cropping	
Rented out land/ shared out	

29. What is/are the reason/s for rented in/shared in?

1) Extra labor that I have 2) land shortage 3) extra input that I have 4) others, specify...

30. What is/are the reason/s for you're shared out?

1) Shortage of seed/fertilizer 2) shortage of oxen 3) shortage of labor 4) due to debt

5) Others specify...............

31. When rented in/out your land, what is the type of agreement?

1) in birr 2) in years 3) in production 4) others, specify.........

32. Does the farmer who rented in your land have responsible to protect, maintain and use some structures/resources already established? 1) Yes 2) no

33. What is the status of your crop production as compared previous years?

1) Increasing 2) decreasing 3) remain the same

34. If decreasing for Q (33), what measures do you take to boost up your production?

1) Using SWC measures 2) using manure 3) using fertilizers 4) crop rotation

5) Others specify ……………………………………………………………………

35. How is the rainfall pattern in your locality? 1) Sufficient and timely 2) insufficient and erratic 3) too much but short duration 4) sufficient but very erratic
5) Others specify………………………………………………………………

36. How do you perceive the fertility of your farmland for crop production?
1) Very fertile 2) fertile 3) less fertile

E. Perception of farmers' towards soil erosion problem and adoption of SWC measures

37. Do you think that your farmlands /plots is/are prone to soil erosion?
1) Yes 2) no

38. What opinion do you have concerning the following statements?

39. If yes for Q (38), how is the extent and seriousness of soil erosion on your land? ……

40. At what time do you observe soil erosion problem on your farm plots?
1) During the first rain showers 2) when the soil is bare (no vegetation cover)
3) During tillage 4) others, specify…………………………..

41. When did soil erosion problem start in your farmland? 1) prior to my birth
2) Since my childhood 3) in recent years 4) I don't know

42. How do you consider the status of soil erosion on your land since starting farming?
1) becomes the worst 2) becomes decreasing 3) no change 4) I don't know

43. What opinion do you have concerning the loss of soil from your farmland?
1) Reducing the depth of top soil 2) reducing water holding capacity
3) Reducing productivity 4) others, specify

44. Do you think that soil erosion will affect your farmland in the future if the present Situation remains unchanged? 1) Yes 2) no

45. What are the main causes of soil erosion in your opinion and rank them. Use the table

Causes of soil erosion	Rank
Overgrazing	
Plowing steep slopes	
High rainfall	
Limited use of SWC measures	
Damaged conservation structures	

Continues cultivation	
Others, specify	

46. What is the trend of soil erosion on your farmland? 1) Increasing 2) decreasing 3) no change
47. Do you think that soil erosion can be controlled? 1) Yes 2) no
48. Do you sense that you are responsible for to conserve your land from the threatening Effect of soil erosion? 1) Yes 2) no
49. What would be the consequence of soil erosion on your land?

Consequence of soil erosion	Rank
Low crop production	
Loss of soil fertility	
Farmland out of cultivation	
Livestock feed shortage	
Increased weed infestation	
Demand extra labor for farming activity	

50. What is the slope of your farm land? 1) Gentle or flat 2) steep and very steep
51. Have you ever used traditional types of SWC measures on your plots? 1) Yes 2) no
52. If you say no for Q (50), what is /are the reason/s? ....
53. If yes for Q (50), which type of traditional SWC measure do you construct?
    1) Traditional ditches/*boyi* 2) *webe/debe* 3) *agdem mares*/contour plowing
    4) Others specify..........
54. Have you ever used introduced/ modern types of SWC measures on your plots?
    1) Yes 2) no
55. If you say no for Q (50), what is /are the reason/s? ....
56. If you say yes Q (52), what kind of modern SWC measures do you use?
    1) Stone bund 2) soil bunds 3) stone faced soil bund 4) check dams 5) cut off drains
    6) Hill side terrace 7) others, specify..

57. What is the present status of the SWC technologies? Use the table

Types of SWC technologies	Present status		
	In good condition	Partially damaged	Completely damaged

58. If any of these is completely/partially damaged, what is the problem/reason?
1) Overgrazing 2) design problem 3 structures by its own 4) purposefully
5) Run off 6) others specify................

59. If the damage is purposefully for Q (56), what is the reason? 1) Harbor pests 2) hinder Oxen plowing 3) take more productive land 4) poor design of structures 5) poor initial construction of modern measures 6) others specify......................

60. If the damage is run off/sheet erosion for Q (56), what is the reason? 1) weakness of the structure done 2) strength of the run off 3)old age of structures due to lack of maintenance 4) others, specify...............

61. How frequent do you maintain SWC structures? 1) Every year
2) Within two years 3) when damage happens 4) others, specify.........

62. Are the maintenance and construction of SWC structures done at the same time or different time with other farm activities? 1) Same 2) different

63. Are SWC structures difficult in terms of labor requirement? 1) Yes 2) no

64. Are the constructed SWC structures effective in controlling soil erosion? 1) Yes 2) no

65. What major problems do you face regarding SWC structures recommended by the Woreda Agricultural Office? 1) Putting up conservation structures
2) Labor competition with other farm activities 3) enforcement without willingness
4) Others specify.............

66. Do you realize a change in yield/productivity with farmland that have SWC Structures and without structures? 1) Yes 2) no

67. How do you construct SWC structures/ technologies? 1) With group 2) family labor
3) *debo/wonfel* 4) others, specify............

68. Which construction procedure is preferable for you?......................why?..................

69. Do you have an intention to implement SWC measures in the rest of your farmland Currently untreated? 1) yes 2) no, why?..

70. Why do you construct SWC measure on your land? 1) Forced to participate 2) To get aid 3) voluntarily, because of its benefit for us 4) others, specify...........

71. What advantage do you observe from SWC structures constructed on your land? Use the table and rank

Advantages/benefits	Rank
Reduced soil erosion	
Increases crop yield	
Maintains the land for the future	
Increases water availability	
Controls flood	
Restoration of grazing lands	
Others, specify	

72. What major problems do you face in establishing and using SWC technologies? Use the table

Problems/ constraints	Rank
High labor requirement	
Occupies cultivable land	
Favors the growth of pests and weeds	
Difficulty to plow by oxen	
Overlap with other farm activities	
Favors the expansion of rodents like rates	
Others, specify	

F. Land tenure and technical assistance by experts

73. For how long have you been with your farmland ....years?

74. How could the newly married of your family member(s) get land?

1) shared the already household land 2) from the *kebele* administration

3) Could not get land at all 4) others, specify…………...................

75. Which one of the following issues is appropriate in your opinion?

 1) Free marketing of land 2) redistribution of land 3) land taxation 4) others...........

76. Do you expect land redistribution for the future? 1) Yes 2) no

77. Can periodic redistribution of land affect your decision to adopt SWC measures?

 1) yes 2) no

78. Do you perceive a risk of loss of your plots of land in the future? 1) Yes 2) no

79. From where do you get technical advice and information concerning SWC Technologies? 1) DA 2) fellow farmers 3) *woreda* SWC experts 4) NGOs 5) others,

80. What kind of support/ information do you get from these bodies? 1) Training 2) Field visits 3) demonstration 4) others, specify………

81. Do you have a good contact with DA? 1) Yes 2) no

82. If yes for Q (80), how many days does the DA visit you per month………..?

83. Do you participate in extension package program that include SWC measures?

 1) yes 2) no

84. Do you receive credit services especially for resource conservation in the previous years and repay the loan on time? 1) Yes 2) no

85. If yes for Q (84), where do you get the credit? 1) ACSI 2) NGOs 3) informal sources 4) Others specify……..

86. In which type of SWC programs do you participate in your farm plots? 1) FFW 2) Free basis 3) others, specify……..

87. Have you got any training concerning SWC techniques and technologies? 1) Yes 2) No

88. If yes for Q (87), who gave the training? 1) *Woreda* agricultural office 2) NGOs 2) DAs 3) others, specify…….

89. Is the training sufficient to improve your skill and knowledge? 1) Yes 2) no

90. If yes for Q (89), do you apply the knowledge you acquired from the training

 1) Yes 2) no

91. What are the general problems encountered in sustaining SWC technologies?

Problems	Rank
extension education is not widely diffused	
SWC technologies are labor, land, capital intensive	
lack of awareness about soil erosion problem and importance of SWC technologies	
shortage of land	
problem of land tenure security	
problem of free grazing	
frequent drought and famine	
Others	

92. What general opinion do you have to improve the current effort towards better soil and water conservation practice in your land?

....

....

....

Appendix 6. Checklists for Key Informant Interview

For development agents, SWC experts as well as agro forestry experts

1. Name..
2. Educational status..........................
3. How long have you stayed in this position?...............
4. How do you perceive about the following in your woreda in general and the study area in particular?
    a) the major forms/types of soil erosion
    b) the major causes of soil erosion
    c) the extent and severity of soil erosion
    d) the perception level of farmers towards soil erosion

e) the response of farmers towards soil erosion problems in the study area.

5. What efforts being done by your office with regard to SWC measures?
6. Is there any SWC package in your *woreda*?
7. If yes, what major strengths and weaknesses does it has?
8. Which kind of SWC measures do you think that the most acceptable and widely disseminated and adopted by farmers? Why?
9. What opinion do you have with regard to the effectiveness of SWC measures in controlling soil erosion problem?
10. What do you think the major factors influencing/affecting farmers for the adoption of SWC structures in the study area?
11. What major problems do you encountered in the application of SWC technologies in the study area?
12. What kind of approach is your office follow in the use, design and implementation of SWC measures?
    - Top_ down? Why?
    - Participatory? Why?
13. How do you see the participation of farmers in SWC works in individual farmlands as well as communal lands?
14. How do you see the FFW/Money for work program?
15. What comments do you have on the planning, designing, implementation and evaluation of SWC works in your woreda as well as the study area?
16. What general opinion do you have regarding the sustainability of SWC works in your woreda?

Appendix 7. Checklists for Focus Group Discussion

For farmers

1. Discuss the soil erosion problems in your farm land.
2. What kind of measures do you implementing in to control soil erosion problem in your farm plots?
3. Are these measures effective in controlling soil erosion problem for your farm? If yes, how?

4. Do you participate in the design and planning of SWC measures before implementation on your farm?

5 Do you get adequate support from agricultural experts such as DAs during implementation of SWC measures?

6 What benefits do you get from SWC measures implemented on your land?

8 What limitation/problem do you face from these SWC measures implemented on your farm plots?

9. Why do you participate in FFW program?

10. What general opinion do you have for the sustainability of SWC measures in your farm plots?

Declaration

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

Declared by:	**Confirmed by:**
____________________	____________________
Birhan Sisay	Feyera Senbeta
Candidate	Advisor