Assessing the Determinants of Farmers' Decision to Use and Maintain Improved Soil and Water Conservation Measures: The Case of Choke Mountain Watershed, Upper Blue Nile, Ethiopia

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I hereby certify that I have read and evaluated this thesis prepared under my guidance, by Yalgaw Yazie Entitled "Assessing the Determinants of Farmers' Decision to Use and Maintain Improved Soil and Water Conservation Measures: The Case of Choke Mountain Watershed, Upper Blue Nile, Ethiopia". I recommend that it to be accepted as fulfilling the thesis requirement for the degree of Master of Arts in Environment and Development.

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DEDICATION

I dedicate this work for my father Yazie Wubetie and my mother Ziyine Getahun as well as my brothers and sisters for nursing me with love and for their unreserved support in all success of my life.

DECLARATION

I declare that this thesis is my work and all sources of materials used for the thesis have been genuinely acknowledged. Brief quotations from the thesis are allowable without special permission provided that accurate acknowledgement of sources is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the College of Development Studies when in his or her judgment the proposed use of scholarship. In all other instances, however, permission must be obtained from the author.

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TABLE OF CONTENT

Page

3. RESEARCH METHODOLOGY

4. RESULT AND DISCUSSION

List of Tables

Page

List of Figures

List of Appendix Tables

List of Appendix figure

List of Abbreviations

ASL……………………….	Above Sea Level
ADLI……………………..	Agriculture Development Lead Industrialization
CSA……………………….	Central Statistics Agency
FAO……………………….	Food and Agriculture Organization of the United Nation
GDP……………………….	Gross Domestic Product
Km………………………..	Kilometer
MM……………………….	Millimeter
MoARD…………………..	Minister of Agriculture and Rural Development
MoFED…………………..	Minister of Finance and Economy Development
UNCCD………………….	United Nation Convention on Combating Deforestation
UNED…………………….	United Nation Environmental Development
SWC………………………	Soil and Water Conservation
VIF………………………	Variance Inflating Factor
CI………………………….	Condition Index
AES……………………….	Agro-Ecosystems
TLU……………………….	Tropical Livestock Unit
DA………………………..	Development Agent

Abstract

Assessing the Determinants of Farmers' Decision to Use and Maintain Improved Soil and Water Conservation Measures: The Case of Choke Mountain Watershed, Upper Blue Nile, Ethiopia

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Ethiopian economy is still highly depends on agriculture, however, the development of this sector is hampered by many factors, among which land degradation mainly due to soil erosion and nutrient depletion coupled with poverty, fast growing population and policy failures has become the most important developmental problems in Ethiopia. Soil erosion particularly is a serious problem in the region in general and in the study area in particular. Although lots of effort has been done to the intervention of conservation program, the success has not been comparable with the efforts made. Therefore, this study was designed and conducted in Choke Mountain watershed with the objectives of examining farmers' perception of erosion problem, extent of community participation on SWC works, effectiveness of technologies and to analyze determinants of farmer' decision to maintain conservation structures. To achieve this objectives, relevant primary data was collected from household survey, focus group discussion, key informant interview and field observation; and also it was supplemented with secondary data collected from various publication, reports, and office contacts. The household survey was collected from a randomly selected sample of 120 household heads drawn from five rural kebeles of five different agro-ecosystem zones of Choke Mountain watershed region by using probability proportional to sample size technique. Descriptive statistics with appropriate statistical tests and binary logistic regression model were employed to analyze collected data. Thus, this research presented important information, justification and findings concerning conservation efforts made in the area. The survey result indicated that only 38% of sample respondents were maintaining constructed conservation measures regularly whereas the rest majority of them (63%) were decided either to remove after just mass construction of the structure or have no interest to maintain it regularly at all. The results also revealed that educational level of the household head, perception of erosion, participation, effectiveness of technologies, extension contact, land ownership and slope of the plot were found to be positively and significantly affected farmers' decision to use and maintain improved soil conservation technologies. Finally, important recommendations which were found to be of paramount importance from the findings of study are suggested for concerned bodies to the attainment of sustainable soil and water management activities which include: community empowerment, genuine community participation, appropriate technology, good institutional support and improved farming practices and appropriate livestock management were recommended.

Key Words: Soil erosion, SWC, Determinants of SWC, Choke Mountain Watershed

1. INTRODUCTION

1.1 Background of the study

The Ethiopian economy is still highly dependent on agriculture, however, the development of this sector is hampered by many factors, among which land degradation mainly due to soil erosion and nutrient depletion coupled with poverty, fast growing population and policy failures has become the most important developmental problem in Ethiopia. Soil erosion particularly is a serious problem in the region in general and in the study area in particular. This sector is also the single largest livelihood means and source of employment for an overwhelming majority of population (CSA, 2008). It also contributes to a very large proportion of the country's GDP (MoFED, 2002). So, as agriculture is the backbone of the country, it is believed to continue by being the determinant sector to bring sustainable economic development to the country (CSA, 2008).

Different reasons and explanations have been given to the low performance of agriculture sector contribution for Ethiopian sustainable development. Commonly mentioned problems are drought, war, pests, insecurity of land tenure, population pressure, soil erosion, overgrazing, deforestation, lack of efficient rural organizations, stagnant technology, distorted economic policies, weak institutional supports, etc (Tesfaye, 2003).

During the last half of the past century and the present decade, intensive use by increasing number of people has gradually led the country's population to overwhelm its productive capacity leading to degraded soils and vegetation over much of the country. The growing demand for natural resources, including water, the consequences of erosion, deforestation and other forms of watershed degradation, the occurrence of natural disasters, as well as increasing out-migration, the pressures of agriculture and the consequences of global climate change are some of the key challenges in fragile mountain ecosystems to implementing sustainable development and eradicating poverty in mountain regions mainly in Ethiopian highlands like choke mountain watershed (Belay, 2012).

For decades, soil conservation programs in the highlands of Ethiopia were premised on the notion that farmers did not perceive erosion and had little or no interest in combating it. Most soil and water conservation planning approaches rely on empirical assessment methods by experts and hardly consider farmers' knowledge of soil erosion. Conservation programs relied on coercive approaches and performed poorly (Yohannes and Herweg, 2000). Failure to balance land management interventions with the current level of land degradation is still a growing challenge to smallholder farmers on the hillslopes to meet both immediate economic objectives and sustainable environment.

Kassie, et al. 2008, found for the Nile basin in Ethiopia that soil and water conservation investments perform differently in different rainfall areas and regions, which underscores the importance of careful geographical targeting when promoting and scaling up soil and water conservation technologies. Even where technologies and incentives are sufficient, there may still be missed opportunities for adoption due to poor information flows to farmers. This is especially a consideration for sustainable land management practices that are knowledge intensive.

The Choke Mountain Range is the water tower of the Region serving as catchments of the upper Blue Nile Basin. Many of the tributaries of the Blue Nile originate from these mountain ranges. Among these are the Gilgel Abay, Birr, Abaya, Gedeb, Chemoga, and Muga rivers that flow into the Blue Nile from all directions at different stages. It is therefore the actual water tower of the Blue Nile and is the lifeline for the millions of people in Ethiopia, Sudan, and Egypt (Belay, 2012).

Investments in soil and water conservation measures mainly on the construction of terraces, soil bunds, gully treatment, irrigation, drainage, use of inorganic fertilizers, etc. contribute to improved land management. Most farmers are aware of the seriousness of soil erosion on their land, nonetheless their investments have been limited. On the one hand these limited investments stem from the inability to do so. This inability is caused by factors internal to the rural poor, such as absence of skill and low education, income and capacity to respond to income-generating opportunities. On the other hand, part of this decision is often determined by farmers' low willingness to invest (Boetekees, 2002).

While traditional land management, including appropriate agricultural practices as well as good forestry practices have extensively protected the Choke from accelerated erosion in the past, today's land abandonment as well as forest mismanagement has dramatically increased the frequency of intensive soil erosion events. Moreover, in the area there is high population growth leads to expansion of cultivation of marginal lands and new human settlement even up to 3600m asl in the mountain area which depletes the main water tower of watershed and biodiversity that leads to sever erosion in the study area (Belay, 2012). Generally, a large number of studies in the highlands of Ethiopia have been carried out on the issue of environmental degradation like;Belay, 2011; Fikru, 2009; Kassie, et al. 2008; Hurni, 1984; Herwege and Lude, 1999; Weldeamlak, 2003; Tesfay, 2003; Mitiku, et al, 2006 and others.

1.2 Statement of the problem

The initial idea for this study was born due to deep observation of the efforts done by public campaign and high mass media coverage regarding to different soil and water conservation practices in different parts of Ethiopia in the last few years, but still its adoption and sustainability as well as its success in maintaining the environment and in increasing agricultural production is not comparable with the efforts made mainly its expense of money, time and household labor.

The prevalence of erosion in Ethiopia is directly visible in major watersheds and basins (Tesfaye, 2003). Especially in the northern parts of Ethiopia mainly in choke mountain watershed, the hills and mountains have suffered from loss of vegetation cover and fertile topsoil, only bare stones is left behind. This is visible from the thick mass of soil taken away by major rivers such as Abay whose major tributaries are originated from Choke Mountain. The soil carried away by this river is partly the result of people's practice and approach of resource management in the upper catchments of choke mountain watershed region. The FAO has estimated an average rate of soil loss of 100 tons ha^{-1} yr^{-1} (or 8mm depth) averaged across the Ethiopian Highlands, with significantly higher rates of erosion identified in the Choke Mountains watersheds (Belay, 2011 cited in Teketay, 2001). This severity of soil erosion and deterioration of its fertility has serious implications for food security for farming communities in the study area.

East Gojjam zone has considerable ecological and socioeconomic significance at the local and national levels in its contribution to food security in Ethiopia. This highland and midland zone has the most favourable climate with land resources suitable to grow large variety of crop and livestock species and it stands as the most intensively cultivated for a long time - it is considered as one of the bread basket areas of the country. However, nowadays the situation is changing due to anthropogenic and natural calamity related constraints. The key problems, among others, are land degradation mainly through erosion and soil fertility loss takes the lion part. Especially in the lowland and fragmented valley and hilly and mountainous highland part of the choke mountain watersheds have steep sloppy landscapes that the population who are lived around this watersheds are highly vulnerable and suffering from chronic food insecurity problems- driven largely due to: land degradation caused mainly by erosion; livestock pressure by overgrazing of lands; depletion of fuel wood resources exacerbated by inefficient cooking technologies and lack of access to improved agricultural technology. The mountain range of Choke is densely populated with an average of 260-270 people per km2. Settlements are fairly common up to 3600m asl and the area up to 3380m asl was cultivated (Belay, 2011). Due to this reason the natural resources base mainly land, water and biodiversity are under intense pressure and the farming communities of the area are facing severe problems of food insecurity (Belay, 2011).

In order to control this soil erosion problem, appropriate measurements particularly soil and water conservation intervention is plainly justifiable and recommended. However, despite the magnitude of soil erosion and efforts made to address the issue in this area mainly in past few years, conservation technologies are still not widely adopted and effectively practiced in the farming communities rather most farmers are interested either to reject totally or being unwillingness to maintain the conservation structures installed in their plots of land. This is happening due to different determinants that affect farmers' decision to use and maintain conservation structures which was already constructed by mass campaigns.

Thus, studies on the determinants of adoption and continuity of SWC technologies mainly by taking account of their decision behavior to maintain conservation structures after just public campaign construction have practical significance particularly for Choke Mountain in which its landscape especially the lowland and valley fragmented and the hilly and mountainous highland parts are highly susceptible to intensive erosion problem and the farmers are highly dependent on traditional farming system.

1.3 Objectives of the study

The general objective of the study is to identify the impact of major determinants of SWC practices and to assess its sustainability in choke mountain watershed region. Specifically this study tries to address the following objectives:

- To understand farmer's perception about soil erosion problem and SWC practices in the study area.
- To assess the extent of local community's participation on SWC programs and activities.
- To see the effectiveness of SWC technologies to enhance land productivity per unit area and in reducing soil erosion in the study area.
- To analyze the major determinant factors that affect farmer's decision to use and maintain constructed SWC measures on their own field.

1.4 Significance of the study

The finding of this study will help to add the stock of knowledge and understanding to the concerned stakeholder mainly governmental and non-governmental organization including extension staff and local community who are involved in the soil and water conservation intervention programs. Almost no studies about the factors that affect the adoption of improved SWC technologies mainly by taking in to account farmers decision on the maintenance of conservation structures that is already constructed by public campaign have been studied in the choke mountain watershed of the highland of Ethiopia. Thus, the finding of this study may contribute for policy makers and intervention programs as guideline to address the real problems and then to conserve and manage natural resources sustainably. It could be also used as a benchmark and reference for those researchers who are interested to study further and in advance regarding to soil and water conservation in this study area and elsewhere in the country.

1.5 Scope and limitation of the study

The scope of this study mainly focuses on assessing the sustainability of SWC practices through identifying and analyzing the determinant factors of SWC efforts within the choke mountain watershed region at the household level. It covers almost the whole choke mountain watershed region which consists of five different agro-ecosystem zones. The findings of the study can be also extended to other areas exhibiting similar agro-ecosystem and socio-economic situation with certain level of adjustment. Like other researches faced, this study also not free from such limitations mainly the data for this study was come from a single survey, and hence, effectiveness of SWC measures in enhancing production were evaluated by comparing before and after implementation of technologies were computed without baseline data just simply by interviewing farmers. And also this study was conducted in choke mountain watershed which is very huge and broad that makes the researcher not to investigate the study in detail enough by taking appropriate sample size- it is only 120 households. This research is also given high emphasis on the soil conservation parts than water management activities in the study area.

1.6 Rational of the study

Previous studies that conducted in different parts of Ethiopia about soil and water conservation activities were given high emphasis to identify determinants of adoption of conservation technologies at the household level; and they were used number and type of constructed conservation structures on particular farmers land as the criteria for classifying farmers in the group of adopter and non-adopter. This means that if three or more (e.g. fanya juu, soil/stone bund, check dames) improved conservation measures are constructed on the particular farmers' land, they called him adopter otherwise the farmer is non-adopter.

However, when we have seen the implementation procedure of SWC program in Ethiopian context, the above given justification may make the researcher to drown inappropriate and false conclusion as well as policy implications. Because as we have seen the implementation of SWC works in Ethiopia, it is mainly carried out through public campaign or mass conservation approaches and hence whether the farmers are accepting the technology or not, participating in mass construction of structures is mandatory for all farmers; as a result all of improved conservation technologies may constructed on those non-adopter farmers land without his interest due to public campaign conservation approach- but the previous researchers were grouped him under adopter groups.

Therefore it is so difficult to say that farmers are adopting the conservation structure in the condition in which that farmer was constructed those measures without his willingness. Due to this critical problem this paper is trying to assess the adoption of technologies by focusing on farmers' decision to maintain conservation structures on their own field just after mass construction of conservation structures. Farmers either removing or not maintaining structures were more likely against the technologies where as farmers who are regularly maintaining constructed measures after mass campaign effort were more likely to accept and adopt the technologies.

2. REVIEW OF RELATED LITRETURE

2.1. Definition and basic concepts on land degradation and conservation measures

Land degradation: is defined as 'the temporary or permanent lowering of the productivity of land. (Young, 1997). Young indicates different types of land degradation that include, soil erosion, soil fertility decline, salinszation, water-resource degradation, forest clearance and degradation, pasture-resource degradation, and loss of biodiversity.

Land management: The technology, activities and strategies employed by land users to manage their land. Land management is sustainable when the available technology, activities and strategies are employed and integrated in such a way as to optimize the current and future land use in food production while maintaining the quality of the natural resources base.

Soil and water conservation: Soil and water conservation is the opposite of land degradation, and aims at preventing, reducing or recovering losses of soil, water and plant nutrients. SWC is the foundation of sustainable land management, given that availability and quality of soil and water are crucial for food production and a healthy environment.

2.2 Land degradation and soil erosion in Ethiopia

Declining Ethiopia's agricultural productivity is both a cause and a consequence of deterioration in the natural resource base on which agriculture depends. According to the UNCCD (United Nations Convention to Combat Desertification), degradation of land involves the reduction of the renewable resource potential by one or a combination of processes acting upon the land. In general, land degradation implies temporary or permanent regression from a higher to a lower status of productivity through deterioration of physical, chemical and biological aspects (Ponniah, 1998).

Direct causes of land degradation are apparent and generally agreed, including production on steep slopes and fragile soils with inadequate investments in soil conservation or vegetative cover, erratic and erosive rainfall patterns and declining use of fallow. Furthermore, limited recycling of dung and crop residues to the soil, limited application of external sources of plant nutrients, deforestation and overgrazing play a significant role in land degradation. There are many underlying causes of land degradation in Ethiopia, including population pressure, poverty, high costs and limited access to agricultural inputs and credit, low profitability of agricultural production and many conservation practices, high risks facing farmers and insecure land tenure. Also the short time horizon of rural households and farmers' lack of information about appropriate alternative technologies are important aspects concerning land degradation. Broadly speaking, causes of land degradation in Ethiopia can be grouped into two categories: natural and man-made causes. The basic man-made factors that ultimately trigger the processes contributing to land degradation are increasing pressures from removal of vegetation cover, poor land use, insecure land tenure, inappropriate land management practices and poverty. Extensive farming systems, which were traditionally in harmony with the environment since only low production was demanded, become inappropriate. Moreover, increasing numbers of the rural population are being forced to farm marginal and unsuitable land, which shell quickly becomes degraded. For example, cultivating hillsides without adequate preventive measures leads to water erosion and leaving soils exposed during fallow periods often leads to wind erosion.

2.3 Trends of Soil and water conservation practices in Ethiopia

To address land degradation and loss of soils, extensive conservation schemes were launched in Ethiopia, particularly after the famines of the 1970s. Since then, huge areas have been covered with physical conservation structure mainly terraces, and millions of trees have been planted (Herweg, 1993; Yeraswork, 2000). And in this period many SWC projects have been implemented in the highlands of Ethiopia for which millions of dollars were spent. However, the legacy of these projects did not leave the country from severe problems regarding to sustainable land use, food security, and natural resource management (Tesfaye, 2003).These projects have made use of farmer labor under the 'food-for-work' project funded by the World Food Program. Farmers were provided with grain and edible oil in payment for their participation in the conservation works. Obviously, food aid has helped to fight hunger in famine-stricken areas; however, the success rate has been minimal. This may be recognized to lack of involvement of local people in planning and implementation of the scheme and poor implementation and maintenance of the soil and water conservation structures (Herweg, 1999). Eventually, when the supply of food-for-work was discontinued, most of the participating farmers became unwilling to participate in the new conservation projects or maintain those already established. Some farmers even removed the structures from their lands (Yeraswork, 2000). Azene (1997) explained that only 25 % of the rehabilitation target has been accomplished and most of the physical soil conservation measures and community forest plantations were destroyed in Ethiopia.

As stated above the conservation endeavor is highly linked to food-for-work payment and these conditions made the conservation intervention to be concentrated only in the areas that are accessible to along the major roads sides. In 1980's, when a massive conservation intervention was underway in the history of the country's soil conservation, but only 7% of the highlands were provided with treatment of the conservation work. This made the initiative to be hardly able to address the problem of soil erosion. Besides, farmers construct conservation structures mainly to obtain food payment. This payment made farmers see the conservation measures belonging to the government rather than themselves. This in turn resulted in poor quality of conservation structures constructed on the farmlands. Very often, farmers destroy these structures to obtain additional food for maintaining destroyed structures (Wood, 1990).

2.3.1 Biological versus physical conservation measures

As different studies and evidences tell us, large-scale SWC projects were implemented in Ethiopia since 1970's which ended in failure because of the dominant conservation methods promoted in the projects were highly focused on physical conservation alone. Due to this wrong ideology most conservation initiatives have been launched mainly by focusing on physical conservation measures that other conservation measures such as biological and agronomic conservation practices that could have potential to provide incentive for adoption have been overlooked. In addition to this, these conservation measures have not been linked to indigenous conservation measures for which the local people are well acquainted. The return from these measures was in general negative at least in the short term (Wood, 1996). They take large proportion of area out of production. According to Campbell (1991), introduced conservation measures through bund and terraces took up to 10% of the precious resource of farmers. Nevertheless, the benefit these structures increase from infiltration and reduced soil loss do not outweigh the loss of land to conservation works and the reduced yields caused by vermin living in terraces, water-logging and disturbance of the soil profile (Wood, 1990). These structures also require frequent maintenance, which is high labor demanding. These all resulted in negative attitude towards conservation in the minds of farmers (Yeraswork, 1988). The most commonly mentioned reason is the cost related to the initial construction and periodic maintenance.

By being aware of this problem, scholars nowadays try to give attention for both physical and biological conservation measures as tool of attaining sustainable soil and water conservation practices (Young, 1997; Hudson, 1993).

A number of structural or physical measures to prevent erosion by controlling the movement of water over the soil surface, and specific to given land conditions and slope, are available for implementation on watersheds includes: contour bunds (also known as contour furrows or desert-strip farming), semi-circular hoops (to catch and retain runoff water), strip cropping, tied ridging (for water management), grass strips, permeable barriers, terraces (bench, diversion and retention terraces), grassed waterways, contour farming (agricultural operations done along land contours), stabilization structures (chute spillways, drop structures, pipe-inlet structures, rock-filled dams, brush-wood check dams, woven-wire mesh dams and other indigenous structures to prevent sediment outflow) and geo-textiles (several types of netting and woven materials from natural fibers) (Hudson, 1995).

Biological measures (vegetative) are preferred over structural measures since concrete, masonry, wood or any other building materials are subjected to decay and liable to be undermined or bypassed. The vegetation prevents soil erosion by reducing the velocity of runoff and providing physical protection from soil scouring (Hudson, 1995). Different afforestation and vegetation measures are incorporated in the various conservation programs which are proposed based upon the slope ranges, and sediment loss.

Crop, animal and land husbandry can be seen as elements of biological conservation measures. The techniques proposed to implement this technology include: farming on grades; strip cropping (useful on gentle slopes); crop rotations; shifting cultivation; mixed cropping and inter-planting; deep tillage; ripping or sub soiling (breaking the hard pan and enhancing porosity); conservation tillage (surface mulching, minimum tillage, trash farming and strip tillage, etc.); reduced tillage (no-till, direct tillage, small strip tillage and rotary tillage, etc.); agro-forestry (plantation- crop combinations); silvipastoral practices; alley cropping (growing food crops between hedges) and combinations of rip-rap and vegetation across and along the slope. However, for soil-conservation recommendations based on slope, a combination of vegetative measures works better than a single physical structure measure (Hudson, 1995).

Therefore, this paper suggests a need of applying a combined list of methods i.e. integrating physical and biological measures as well as indigenous and new introduced measures should be applied for a given slope and land use type, and accordingly of the different agro-ecological zones in choke mountain watersheds particularly and in the country broadly. The table shown below indicates some of different soil and water conservation measures that should be applied in different land use pattern based on their suitability for specific agro-ecological zones

Table A- Different conservation measures and their suitability in land use and agro-ecology

A. Physical soil and water conservation measure				
		Suitability based on agro- ecology		
Measures	**Main land use**	Arid (Kolla) up to 500 mm	Semi-arid (dry weyna dega) 500-900 mm	Medium/high rainfall areas (weyna dega/dega)> 900 mm
Soil bunds	Cu, Hcu, Gr	Suitable with large trenches	Suitable with trenches	may need to be graded In dega
Stone bunds	Cu, Hcu, Gr, Ms, FrSr	Same as above	Suitable +/- trenches	Suitable without soil fill on the upper side of bund
Fanya juu	Cu, Hcu, Gr	Not suitable	Suitable +/- alternative with trench soil bund	Suitable in deep soils & graded in dega zone
Bench terraces	Cu, Gr	Suitable with runon/runoff system	Suitable	Suitable +/-may need excess water disposal structure
B. Soil fertility management and biological soil conservation				
Contour cultivation	Cu, Hcu	Suitable with SWC measures	Suitable with SWC measures	Partially suitable (specific soils

				only)
Compost making	Cu, Hcu, Ms	Suitable mostly around home	Suitable (pit method)	Suitable (pit or heap method)
Efficient use of fertilizer	Cu, Hcu	Suitable only with additional water supply & conservation	Suitable with additional water & drought resistance Spps	Suitable with conservation and drainage control
Crop rotation	Cu, Hcu	Suitable with SWC and irrign	Suitable	Suitable
Inter cropping	Cu, Hcu	Suitable	Suitable	Suitable
Improved fallowing	Cu, Hcu, Gr	Generally not suitable	Suitable with other measures	Suitable
C. gully, flood and drainage control				
Stone checkdam	Gu crossing various land use	Suitable	Suitable	Suitable
Gully filling	Same as above	Suitable	Suitable	Suitable
Cut off drain	Below FsSr	Suitable	Suitable	Suitable
Vegetative waterway	Cu, Gr	Not suitable	Suitable with drop/apron stcr.	Suitable
BBM	Cu	Not suitable	Not suitable	For >1000 mm

Cu-cultivated land, Gr-grazing land, Fs-forest land

Source: MoARD, 2005

2.4 Community participation in SWC practices

Northern Ethiopian Highlands, including that of Choke Mountain, are characterized by high land degradation and natural resource depletion resulting from various factors such as climatic variations and human activities (Gebremedihn, 2004). Therefore, genuine community participation associated with sustainable soil and water conservation management is vital to correct the situation. Besides, participation of different types of stakeholders is now considered to be essential for effective and sustainable management and conservation of the natural resource systems though the use of external inputs should decrease in the long run. It appears that the community should be convinced to make changes in the SWCM to contribute toward its own improved sustainable livelihood. The first important step prior to identification of village specific land and water management sites was the preparation of management plan; and thus the plan took into account the issue of demands of the community on land and water conservation and the integration approach for effective implementation of the program (Mishira, 2007). The village community played an active role during the planning stage by expressing their needs during the preparation of SWC programs. The participatory process of planning and implementation was the cornerstone in the linkage between their felt needs and the SWC intervention programs.

According to (Woldeamlak, 2003) findings at chemoga watershed, majority of the farmers participated in the SWC against their will. The most important factor discouraging them from participating freely was the perceived ineffectiveness of the structure under construction. Awareness about soil erosion as a problem, labor shortage, and land tenure insecurity were found to be less important in providing explanation for the disinterest shown by most of the farmers towards SWC activities. Therefore, the important factors that needs immediate consideration for SWC programs is careful designing and constructing of the structure by taking account the ground realities and also the participation of farmers have to be through their own conviction or willingness regarding the effectiveness and efficiency of the technologies.

2.5 Empirical studies on factors affecting decision of farmers to use and maintain SWC structure

The sustainability of farmers' soil and water conservation practices are affected by the interplay of social, economic, institutional, technological and biophysical factors. Even though some factors are more important than others under a given situation, attention should be given to all of them in order to ensure the sustainability what farmers do in soil and water conservation.

2.5.1 Socio-economic factors

Perception of erosion problem: In various studies farmers' perception of soil erosion and their subsequent conservation behavior have mixed results. In some studies, there was no substantial relationship between soil erosion perception and farmers' conservation behavior, whereas other studies show that as there is direct links. For example, the perception of erosion was found to be important to the adoption behavior of SWC in the Enemay districts (Derjaw, 2008), Philippines (Cramb, *et al.*, 1999) and at Andit Tid, Ethiopia (Bekele, 1998), showed that farmers' decisions to retain conservation structures are positively and significantly related to soil erosion perceptions, attitude towards new technology and exposure to new practices. On the contrary, Woldeamlak (2003) in his study found that in spite of high level of farmers' perception of erosion problem, the level of adoption of conservation structures was very limited. Kessler (2006) found that perception of the problem did not influence farmers' decisions on how much to invest in soil and water conservation. Following low level of adoption of conservation structures in spite of high level of perception of soil erosion, however Woldeamlak (2003) was concluded that perception of the erosion problem is not a sufficient condition for adoption of conservation practices though it is a necessary one.

Education*:* Education influences farmers' decision to adopt technologies by enhancing farmers' ability to obtain, understand and utilize the practice, and by improving overall managerial ability of farmers (Etana, 1985). Many previous studies indicated that educational attainment affects conservation measures adoption decision positively. Ervin and Ervin (1982) found that education was significantly related to conservation efforts. According to them, farmers who are more educated are more likely to use contouring, minimum tillage and hay or pasture rotation to control soil loss. According to Saliba and Bromley (1986), education enhances farmers' willingness to adopt new management practices by improving the managerial capacity of a farmer. Long (2003), predicted the positive and significant association between education and adoption of conservation measures. Traoré et al (1998) supported the above findings and concluded that education is an influential factor in the adoption of practices that conserve soil and water.

Generally, most of the studies which undertaken previously clearly indicated that when the farmers are educated more and more, they tended to adopt and apply different soil and water conservation technologies as well as have the intention to maintain once constructed conservation structure which ensure the sustainability of soil and water resource management.

Age*:* Age is believed to influence conservation practice decision because of its influence on planning horizon (Long, 2003); for example some conservation measures such as terrace are long term investments. On the contrary, older farmers usually have short planning horizon and they may be less interested on long term negative effects of resources depletion (Bromley, 1980). This implies that they have higher discount rate and this reduces the present value of long term return from conservation based agriculture. Korschig et al (1983) compared the mean age of adopters and non-adopters of soil conserving technologies and identified that the mean age of adopters was 49.9 years and that of non-adopters was 55.1 years. And also Bekele (1998) and Wagayehu and Lars (2003) in their study in different parts of Ethiopia found negative association between existence of conservation structures (adoption) and age of household heads; and they predicted the positive association between age and non-adoption of conservation measures. However, Long (2003) and Traoré et al (1998) found that older farmers are not less likely to use conservation practices on their agricultural land. Hence, the effect of age on adoption of conservation structure is area specific.

Therefore, based on the above studies argument, whether it is positive or not age has a significant impact on the sustainability of soil and water conservation practices. Here is mind that other studies did not indicate the influence of age in different dimension. For instance nowadays there is alarming population growth and the land holding size per individual tends to very low and the older farmers have relatively large farm size than the younger and those younger farmers mostly consider practicing conservation technology on their small plots as losing of productive land due to physical installation of conservation technologies. Due to this reason the older farmers can adopt better than young farmers but this issue was not given due attention by previous studies.

Household size: Physical conservation measures are labor intensive technologies. Studies conducted in Ethiopia indicated that, for installation of recommended physical conservation measures, about 50 and 70 persons per days per hectare for soil and stone bunds, respectively, were estimated to be required (Wagayehu and Lars 2003). Woldeamlak (2003) also identified lack of interest in soil and water conservation measures to be explained by shortage of labor. Thus, household size influences the decision of farmers to undertake the conservation measures that the given household labor is the whole supplier of the required labor for undertaking the farming and soil conservation operation. This was supported by Geoffer (2004), who found that household size was associated positively with adoption of conservation practice.

Yet, some studies conducted in Ethiopia indicated the reverse that in the large families with greater number of mouth to feed, immediate food need is given priority and labor is diverted to off-farm activities that generate income for household food consumption. Hence, even during slack season, opportunity cost of labor for the household with greater size will be higher (Wagayehu and Lars, 2003).

2.5.2 Physical factors

Physical factors are well established and crucial actor in the soil-erosion process and for SWC, and hence serving as a foundation for the technical options. So, physical characteristics played an important role in shaping farmers' SWC decisions. These are outlined below:

Slope: Like rainfall and nature of soil that affect erodibility, slope of a field affects the rate and amount of soil loss from fields. Farmers take SWC practices more seriously when they are farming on steep land. Farmers in Konso started a unique SWC system because their landscape is dominated by steep slopes (Tesfaye, 2003). This forces farmers to control or mitigate the impact of erosion on fields that are situated in steep slopes and hence slope influences the decision of farmers to undertake conservation measures. Saliba and Bromley (1986) observed that farmers cultivating steep slope fields install more effective conservation measures than farmers that cultivate level fields. On the contrary, farmers in less erosion prone areas (level fields) do not employ conservation measures on their farmlands. They observed frequent conservation practices installed on steeply sloping cultivation fields which reflect the desire of farmers to control soil loss from highly erodible soil. Tesfaye (2003) and Woldeamlak (2003) found positive association between existence of recommended type of conservation structures and concluded that slope affects farmers' decision to adopt conservation structures positively.

Table B- Range –based categorization of slope

Slope classes	Range (%)
Flat or almost flat	0-3
Gently sloping	3-8
Sloping	8-15
Moderately steep	15-30
Steep	30-50
Very steep	>50

Source: MoARD, 2005

Soil Fertility: Farmers will not be interested to invest in conservation and bear associated risks if they do not perceive significant threat posed on productivity due to soil erosion (Wagayehu and Lars, 2003). Farmers perceive the effect of soil erosion when it reaches some critical level, which is very difficult to reverse the degradation at the subsistence farmer level (Woldeamlak 2003). On deep or fertile soil, erosion process does not affect farmers at least in the short term. The symptoms of erosion can be easily plowed away and on such sites there may not be a big effect on productivity of land although the problem is recognized. Farmers cultivating such lands are reluctant to apply soil conservation measures. In contrast to this, Wu and Babcodk (1998) found that farmers that cultivate low quality land adopt conservation practices less frequently. This is supported by Wagayehu and Lars (2003). They used soil color as a proxy to soil ferity and found negative correlation between black colored soil (fertile soil) and no conservation decision indicating that the tendency of farmers to invest more to conserve black (fertile soil) where the marginal loss of productivity due to erosion is higher.

Proximity: Farmers residing close to their cultivation land invest more on soil conservation measures than their counterparts living at distance. This is because cultivation land closer to the residences receives more attention and supervision than land that is situated at the farthest distance. Farmers also want to invest more in the field that require least effort (Kessler, 2006). He also found out that farmers invest more in soil and water conservation in fields situated near to residences. Wagayehu and Lars (2003) found significant and positive correlation between distance of the plot and adopting conservation decision. They attributed the negative association for the location factor that increases the labor cost due to time spent on travel.

2.5.3 Institutional factors

Extension services and information: Agricultural and rural development in Ethiopia, although claiming that it includes people's participation, remains only delivery-oriented in terms of its extension service rather than encouraging farmers' innovations. Extension systems formulate and promote 'on-the-shelf' package technologies that result from past research. The overall organizational framework of the system is designed on the basis of a locally developed extension approach called the Participatory Demonstration and Training Extension System (Tesfaye, 1999), but much is still desired on the technical side, methodological shortcomings leads to the limited success of the largest conservation programs in Ethiopia over the last few decades and even today. Farmers seek to reduce uncertainty about conservation innovations through information. Farmers who know nothing about a practice cannot be expected to adopt it unless they understand its expected costs and benefits. Accurate and timely information has a positive impact on farmers' conservation adoption decision. More informed farmers better assess the impact of soil erosion on long-term productivity of their farmland and adopt practices that help resolve the problem of soil degradation (Fikru, 2009). The study conducted in Ethiopia indicated that if a farmer receives better information and advice from extension agents, the farmer will be willing to construct new conservation measures and to maintain the existing installed conservations (Wagayehu and Lars, 2003).

Land tenure: land tenure security influences farmers' decision to adopt conservation measures by influencing the length of farmers' planning horizon and sense of responsibility in which farmers will not be interested to invest in soil conservation measures when the land tenure is too insecure so that the benefits of soil conservation may not accrue to them. The study made in different parts of Ethiopia attributed the low level of success of natural resource conservation due to land tenure insecurity (Yeraswork, 2000; Woldeamlak, 2003; Wagayehu and Lars 2003; Bekele, 1998) and they found the negative association between land tenure insecurity and farmers decision to retain conservation structures on their fields. Since stable land tenure is very important for adoption of major investments especially terrace construction the low level of retaining conservation structure throughout the country is attributable to land tenure insecurity.

On the contrary to the above findings, Geoffrey (2004) in his study in Zambia and Tesfu (2011) in his study in Habru district, Northern Ethiopia found no association between adopting conservation measures and land tenure security.

Incentives: Incentive for SWC is mostly stimulated in the form of food-for-work programs in the previous years even today through productive safety net programs in selected district of the country. The most crucial issue to be considered before deploying incentives, however, is acceptability of the new practices in the face of the evaluative frames of reference of farmers envisaged in the incentive. The reason for this condition is that the farmers are expected to continue the new practice after the phasing out of the incentive. That means that the incentive was deployed merely to overcome risk-aversion by farmers and to increase their relative advantage. This phenomenon is termed as 'dynamic dis-equilibrium' where the use of incentives in the form of a subsidy could be considered as economically justified (Giger, 1998).

Incentives can be provided in a variety of ways, including credit, subsidies, grants and infrastructure. Reij (1998) sees incentives as a triggering mechanism for the adoption of SWC technologies for example in Burkina Faso, he reported on a new initiative to provide a donkey cart for the transportation of stones, manure, water, firewood, etc., which directly or indirectly contributed to land management, instead of the expensive option such as a lorry that would not be sustainable after the project terminated. The most important issue with respect to access to credit is its link with land management; i.e. is credit used for hiring extra labor, purchasing fertilizers or other inputs; if it is used for other purpose this incentive is done nothing for the sustainability of soil and water conservation practices.

Therefore, mere access to credit does not guarantee for proper land management as credit could be used for consumption. In this connection, some studies reported that increasing the amount of credit brought on a slightly to medium significant negative effect on the willingness to maintain SWC structures and they noted that such unusual results regarding credit occurred because the conservation technology was labor intensive rather than capital intensive, whereby cash constraint plays a minor role.

2.5.4 Technological factors

The diffusion of innovation school has always paid attention to the characteristics of innovation itself in addition to its traditional focus on the innovators in trying to determine the rate of adoption of an innovation (Rogers, 1995). The variation in rate of adoption in new soil and water conservation technology among farmers is mainly by five attributes of the innovation or technology includes: relative advantage, compatibility, complexity, trialability, and observability. Not only the above but also the agent-communication channels related issues affect an innovation's rate of adoption. Therefore, the five perceived attributes of technology together with the agent-channels related issues determine the rate of adoption of newly introduced conservation technologies among farmers in different agro-ecosystem regions of the study area.

Like any other technology, characteristics of conservation technology also affect the farmers' decision to adopt and implement soil and water conservation practices almost in all parts of the country. From the technological characteristic point of view, farmers go into all these details based on their day–to-day observation of each technology. When they are new to the technology, their reservation may be due to complexity, observability, which also prohibits farmers' evaluation of the relative advantages and compatibility of the technology. The relative advantage issue also raises the need to incorporate SWC practices that give quick benefits to offset the side effects of the technology, with low cost and low labor demands (Renaud, *et al.*, 1998). So, SWC technologies also should consider side effects that increase farmers' risk of crop loss (Belay, 1992; Herweg, 1993). These side effects include: water logging, rodents, weeds, land occupied by conservation structures, obstacles to routine farm operations. These features highly reduce the adoption of SWC technologies among small farmers.

2.6 Conceptual framework

This study generally aims at assessing the continuity of SWC practices by investigating the major pillars of sustainability in choke mountain watershed. The adoption and continuity of SWC practices are influenced mainly by economic, social, institutional and biophysical factors. With respect to soil and water conservation, the first issue is the state of land degradation and the level of soil erosion; when the household feels the impact of soil erosion in its farm, it is expected to take the necessary measures and its response depends primarily on the level of his perception on soil erosion and the resulting attitude. However, soil and water conservation does not fall only within the domain of personal behaviors in which one can easily do what one intends. Therefore, for the success of soil and water conservation efforts and intervention, it requires recognition of socio-economic, institutional and biophysical nature of target population and lastly to be effective and sustainable, considering and integrating of these all issues becomes a must.

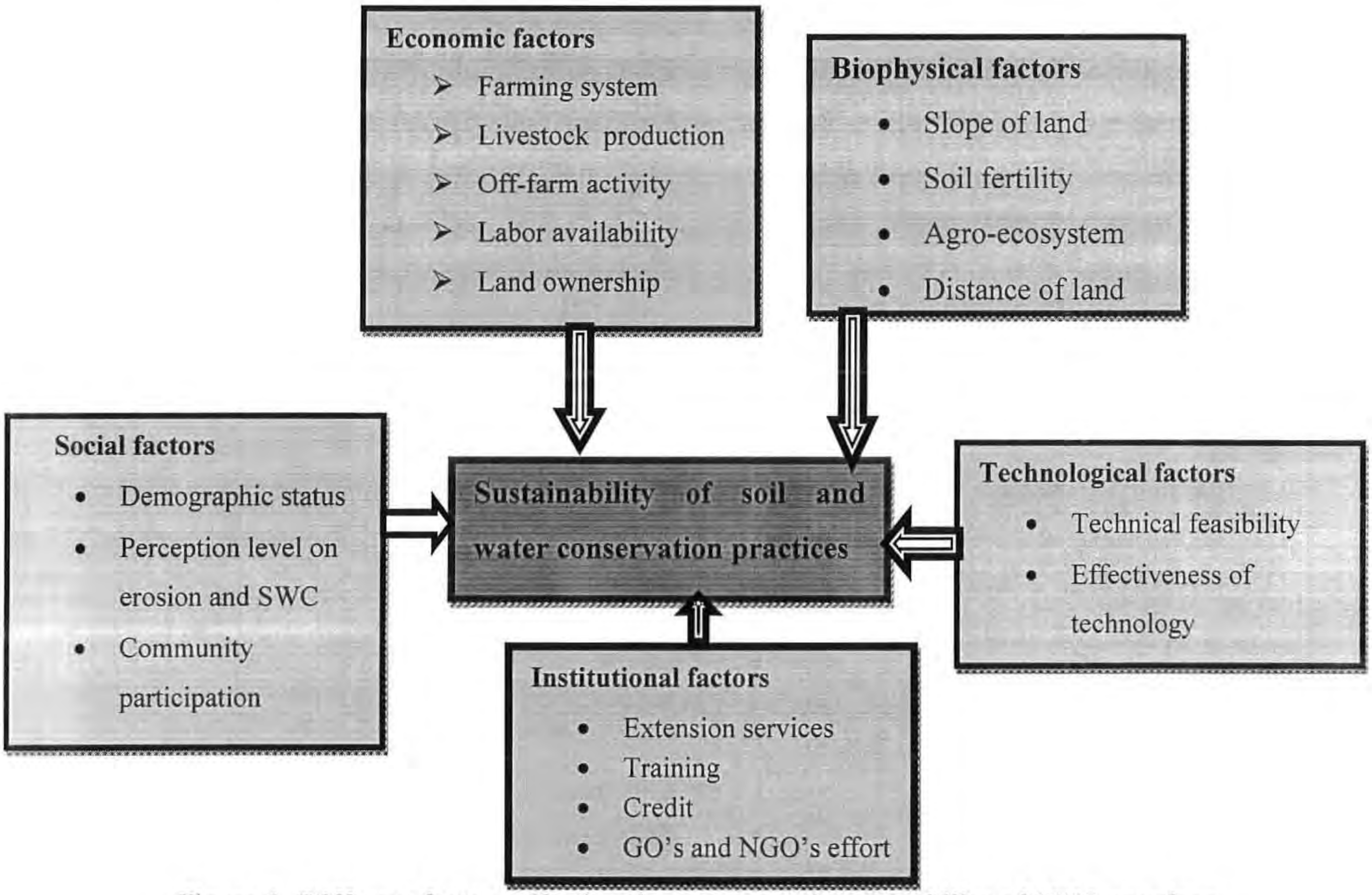

Figure 1- Different factors affecting the success and sustainability of SWC practices

Source: Modified from Habtamu (2006)

3. RESEARCH METHODOLOGY

3.1 Description of study area

This section tries to show the location, topography, climate, socio-economic conditions and natural resources mainly soil, water and forest resources of the study area.

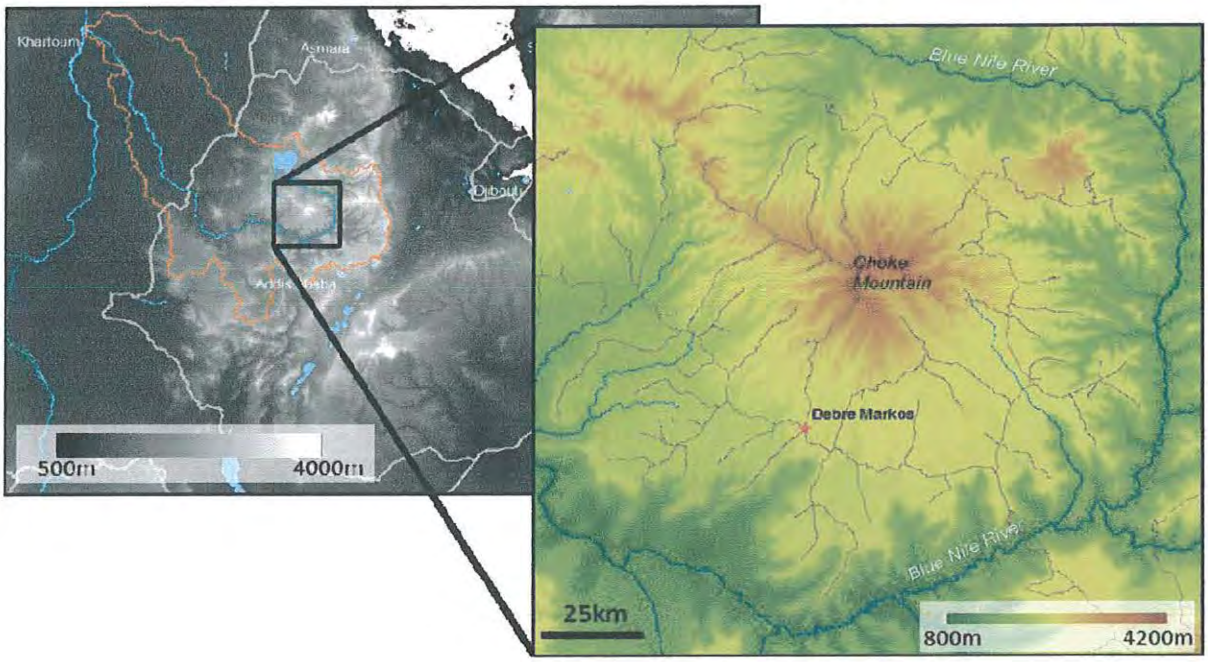

Figure 2 – The location of Choke Mountain watershed region **Source: Belay Simane, 2013**

Note: At the map of Ethiopia, the red line indicates the outline of the Blue Nile River Basin and shading is indicating topography

- In the Choke Mountain region inset colors are topography
- Blue lines are major rivers
- Grey lines are roads

See more the map about the six agro-ecosystem zones of the Choke Mountain watershed in the appendix part.

Topography- Choke Mountains is a large block of highland found in central Gojam, Amhara Regional State. It is located on plateaus that rises from a block of meadows and valleys and have elevation ranging from approximately 800 - 4200 meters above sea level. The central peak is located at10^0 42' N and 37^0 50' E. While the central cone of the mountain chains of Choke occurs in six districts of East Gojjam, namely Hulet Eju Enesie, Enarj Enawga, Sinan, Debay Telatgin, Bibugn and Machakel, the Mountain watershed includes all East Gojjam and part of West Gojjam (Belay, 2012).

Socio-economic condition: The mountain range is densely populated, with an average of 260-270 people per km^2. Settlements are fairly common up to 3600m asl. At present, there is an extensive agricultural activity up to 3380m asl, including on steep slopes, even though slopes are predominantly gentle to moderately steep (13-55%). Even steep slopes were put under cultivation. East Gojjam zone has considerable ecological and socioeconomic significance at the local, national, and regional levels in its contribution to food security in Ethiopia. This highland zone has the most favourable climate with land resources suitable to grow large variety of crop and livestock species, it stands as the most intensively cultivated and is considered as one of the bread basket areas of the country. However, the situation is changing due to anthropogenic and environment related constraints mainly land degradation (Belay, 2012).

Commonly grown crops include, Barley, Teff, Faba Beans, Potato, Maize, sorghum are grown in different parts of the region. Potato is extensively cultivated and comprises the main marketable produce. Potato fields are seen as high as 3140m asl. Maize was grown at high altitudes, at 2900m asl which is a new phenomenon, ascribed to climate change. Engido, a newly introduced fodder crop, now used as food crop, was cultivated as high as 3450m asl. Telba was grown at high altitudes, i.e. 3550 m asl. Sorghum was grown mainly in lowland parts (Abay gorge) of the watershed region. The mountains are totally unprotected and are critically threatened by the rapid expansion of agriculture and overgrazing resulting in excessive soil erosion. This has resulted in highly reduced agricultural productivity of the land and exacerbated food insecurity of the inhabitants of the mountain range. The land below 3600m asl was extensively used for crop production, while the higher grounds was used for grazing of small ruminants, primarily sheep, and horses , or not used at all.

Climate- Seasonal precipitation is tightly correlated with the movement of the Inter-tropical Convergence Zone (ITCZ), with most rain falling during the May-October *kiremt* rainy season. The distribution of precipitation within the Choke is far from uniform; average annual precipitation ranges from 600 to 2000 mm yr^{-1}, and exhibits strong local variability associated with topographic gradients (Krauer, 1988). Precipitation events are convective in nature, and are characterized by short, sometimes intense erosive bursts with notably large raindrops (Nyssen et al., 2005). Latitude, altitude and humidity have significant impact on temperature condition in Ethiopia. Mean annul temperature of the area is 16.7 0^C and mean minimum and maximum temperature of the area are 10.8 0^C and 22.6 0^C respectively. The warmest months of the area are between February and May. In these months, average temperature of the area reaches to 17.8 0^C. On the contrary, the coldest months of the study area range between June and August where the average monthly temperature reaches to 15.6 0^C. Frost occurs in October and November occasionally (Belay, 2011).

Soils: The dominant soils are Leptosols (34%), Vertisols (26%) and Nitosols (23%). Phaeozems and Andosols dominate at higher altitudes and to the northern portion of the region. Vertisols tend to form at footslopes throughout the region (Nyssen et al., 2000). The Choke Mountains (headwaters of the Blue Nile) is characterized by long steep slopes intensively used for agriculture and forestry, high intensity rainfall and significant direct runoff generation and erosion, high ecological degradation, a high and steadily increasing population pressure, and vulnerability to climate change. High rates of on-field erosion are particularly problematic given that nutrients in Choke soils tend to be concentrated in the upper portion of the soil column. The FAO has estimated an average rate of soil loss of 100 tons ha^{-1} yr^{-1} (or 8mm depth) averaged across the Ethiopian Highlands, with significantly higher rates of erosion identified in the Choke Mountains watersheds (Teketay, 2001). This physical transformation has serious implications for food security. For example, Tekatay (2001) estimates that in 1990 alone, reduced soil depth due to erosion resulted in production loss of 57,000-128,000 tons in Ethiopia—a volume that would have been sufficient to feed more than four million people. Nevertheless, there are still significant soil resources in the Choke catchments, and experience indicates that productivity can be maintained and enhanced through effective field scale and landscape scale land management as Belay, 2012 cited in (Bishaw, 2001; Dejene, 2003).

Water: The Choke Mountain Range is the water tower of the Region serving as catchments of the upper Blue Nile Basin. Many of the tributaries of the Blue Nile originate from these mountain ranges. Among these are the Gilgel Abay, Birr, Abaya, Gedeb, Chemoga, and Muga rivers that flow into the Blue Nile from all directions at different stages. It is therefore the actual water tower of the Blue Nile and is the lifeline for the millions of people in Ethiopia, Sudan, and Egypt (Belay, 2012).

Forest: The livelihoods of the communities on the Choke Mountain Range are primarily dependent on biomass-based subsistence economy. Communities depend on biomass for their fundamental needs like food, fuels, construction materials, and raw materials for various traditional crafts, most of which are collected freely from the immediate environment. There is no significant natural forest cover of this mountain range. The major natural habitats are moist moorland, sparsely covered with Giant Lobelia spp. Jibara/Jibbra, lady's mantle *(Alchemilla spp.),* Guassa grass *(Festuca spp.)* and other grasses. There is very little woody plant cover; Erica sp (Asta) and *Hypericum revolutum* (Amijja) are found in patches. Bamboo or *Kerkeha-Arundinaria alpina-* is found both as a homestead plantation as well as part of the natural vegetation cover in the area, albeit very sparsely. Korch-Erithrina brucei-is commonly grown as border demarcation plant in the area. *Eucalyptus globulus* is extensively gown as a plantation, and some of the residents of the area have become dependent on it for their livelihood.

3.2 Source of data and method of data collection

This study combined both qualitative and quantitative methods to generate data. The quantitative method was involved the use of household survey while qualitative methods were used focus group discussion, key informant interview and direct personal observation. And as a source both primary and secondary data were used to generate data from the study area.

3.2.1 Source of primary data

The following techniques or instruments were employed to generate the primary data which include:

Household survey: Structured household survey questionnaires were used to obtain information from 120 sample households who were selected from five different agro-ecosystem zones of the study area. The main focus that the questionnaires were targeted include mainly on household demographic characteristics, socio-economic characteristics, issues related to soil and water conservation trends and the existing challenge and determinant factors to the sustainability of soil and water conservation practices. For the sake of conducting this household survey, around 5 enumerators were assigned in the data collection process. Those enumerators were oriented and given guidance by the researcher before handling the survey to make them informed about the purpose of the study as well as to familiarize them with the questionnaire.

Focus group discussion: Focus group discussions were used as one of the main source of primary data in addition to household surveys. Therefore, one FGD was held in each sample village from five agro-ecosystem zones by the help of checklists. The numbers of participants in each sample village were ranged 8 up to10 participants and the members were consist of local administrators, elders, youngsters including women farmers. The leading questions in the checklist were prepared by giving high emphasis on the issues of; perception regarding to soil erosion problem and SWC practices, trends of soil and water conservation activity in the study area, level of local community participation in SWC practices over time, effectiveness of introduced SWC technologies in different agro-ecosystem zones, their decision to maintain constructed conservation measures; and the existing challenges and determinants to use and retain conservation measures.

Key informant interview: A key informant interview was particularly important in getting information pertinent to the institutional aspect of soil and water conservation practices. Valuable information regarding the views of experts from zonal and district agriculture and rural development offices , officials of local NGO's working on environment related issues; and development agents from respective kebeles as well as village administrators from sample villages were collected through this method.

Field observation: Direct personal field observation was arranged by targeting on the visiting of cultivated and non-cultivated land to see the extent of soil erosion on this land; the implemented soil and water conservation practices on the field; and also to see overall nature of natural resources existed in the study area. Transect walks and visits to individual plots created an opportunities for closer observations of the severity of soil erosion and different conservation structures constructed at the field and their maintenance status. Land characteristics like slope, soil type, vegetation cover and other parameters were observed and assessed during field observation.

3.2.2 Secondary data

The primary data was supplemented and supported by reviewing documents from other secondary sources mainly from:

- Books, journals, conference proceedings
- previous research work (Master thesis and PhD dissertations)
- Official and project reports and other documents.

3.3 Sampling procedure and sample size

This study was followed multi-stage sampling frame by considering mainly different agro-ecosystem zones of the study area rather than considering its geographical location. Therefore, firstly five agro-ecosystem zones (Lowland and valley fragmented, Midland plains with black soils, Midland plains with brown soil, Midland slopping lands and Hilly and mountainous highland) were selected from six agro-ecosystem zones of the region purposively for its relevance to the study; the sixth agro-ecosystem zone (Afro alpine- Choke protected area) was not consider since there is no human settlement there and this research was focused on household survey at household level-it is already protected area.

Then one kebele from each agro- ecosystem zone with a total of 5 kebeles were selected randomly; meanwhile 120 sample household heads were also selected randomly by probability proportional to size of each kebele. Principally, the sample size required depends on the required precision, the variance of variables among the total population, and the sampling technique. In practical terms, however, the sample size is often restricted by the available fund, time and other related reasons.

Therefore, considering financial constraints, time shortages, lack of transportation and other infrastructure facilities, 120 sample households were selected randomly for analysis of main interest of the study. Whereas participants in the key informant interview and focus group discussion was selected purposively for the sake of getting good information.

3.4 Methods of data analysis

The quantitative and qualitative data which was collected from sample households were analyzed by descriptive statistics and Econometric model by using SPSS.16 version soft ware as a tool of analysis.

3.4.1 Descriptive statistics

Descriptive statistics are important analysis techniques to describe and to have a clear picture of the characteristics of sample units. By applying descriptive statistics, it is possible to describe and to compare and contrast different categories of sample units among farming household heads with respect to the desired characteristics. Therefore, in this study, descriptive statistics such as frequency, percentage, mean and standard deviation along with the appropriate statistical tests mainly t-test and x^2-test were used to analyze the collected data from sample households at the study area.

3.4.2 Econometrics model

A variety of econometrics models can be used to establish a relationship between different factors and the decision of households to construct and maintaining soil conservation structures. Conventionally, linear regression analysis is widely used in most economic and social investigations. This is because; it has some desirable properties for specific type of enquiry and data and is widely available in computer packages (Green, 1991). Moreover, it is easy to interpret and it is a reasonable procedure, however, the same source further stated that while estimates derived from linear regression analysis may be robust in the face of errors in some assumptions. Therefore, it has some weakness, for instance, the linear probability model may generate predicted values outside the 0-1 intervals, which violates the basic principles of probability. The other problem with LPM is that the variance of the disturbance term is heteroschedastic. Furthermore, the assumption of normality in the disturbance term is no longer tenable.

Therefore, the inadequacy of the linear probability model suggests that a non-linear specification may be more appropriate and the candidate for this will be an S-shaped curve bounded in the interval of 0 and 1 (Maddala, 1983). These authors suggested the S-shaped curves satisfying the probability model as those represented by the cumulative logistic function (logit) and cumulative normal distribution function (probit). The choice between these two models revolves around practical concerns such as the availability and flexibility of computer program, personal preference, experience and other facilities. In fact it represents a close approximation to the cumulative normal distribution.

Hosmer and Lemshew (1989) pointed out that a logistic regression has got advantage over others in the analysis of dichotomous outcome variables. There are two primary reasons for choosing the logistic distribution. These are 1) from a mechanical point of view, it is an extremely flexible and easily used function, and 2) it lends itself to a meaningful interpretation. The logit model is simpler in estimation than the probit model. Therefore, a binary logistic regression model was used to study the decision behavior of sampled households; and why binary was because the dependant variable (farmers' decision to maintain conservation structures) has the nature of dichotomous or binary responses.

Following Gujarati (2004), the logistic distribution function for identification of farmers' decision in retaining of conservation structures can be defined as:

$$Pi = E\left(Y = \frac{1}{Xi}\right) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 .. + \beta m Xm)}} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots 1$$

Since, $Zi = \beta_0 + \beta_1 X_1 + \beta_2 X_2 .. + \beta m Xm$ the above formula can be rewrite as shown below for easy of understanding.

$$Pi = \frac{1}{1+e^{-zi}} = \frac{e^{zi}}{1+e^{zi}} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots 2$$

The above formula indicates that as the value of Z_i ranges from negative infinitive to positive infinitive, Pi the probability of households' decision to maintain soil conservation structures ranged between 0 and 1. Therefore, when (Pi) is the probability of households to regularly maintain the conservation structures, (1-Pi) then will be the probability of households to not maintaining the constructed conservation measures. This can be represented as:

$$1 - Pi = \frac{1}{1 + e^{Zi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Now the most important element in the logistic regression i.e. odds ratio that can obtained from equation (2) and (3) which is represented as $\frac{Pi}{1-Pi}$ as shown in the following expression:

$$\frac{Pi}{1 - Pi} = \frac{1 + e^{Zi}}{1 + e^{-Zi}} = e^{Zi} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

The odds ratio in logistic model shows the extent or degree of favoring the households maintaining conservation structures regularly.

When we take the natural logarithm of equation (4), we can obtain the following formula for logit model which mostly represented as Li:

$$Li = \ln\left(\frac{Pi}{1-Pi}\right) = Zi = \beta_0 + \beta_1 X_1 + \beta_2 X_2 .. + \beta m Xm \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Then if the disturbance term Ui is taken in to account the logit model becomes:

$$Zi = \beta_0 + \sum_{i=1}^{m} \beta i Xi + Ui \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Where:

β_0= the intercept. It is the value of the log odd ratio $\frac{Pi}{1-Pi}$, when X or explanatory variable is zero.

$\beta_{1=}$ the slope, measures the change in L (logit) for a unit change in explanatory variables (X);

Before running the models, it would be necessary to check whether there is multicollinearity among the explanatory variables and verify the degree of association among these variables. The reason is that the existence of multicollinearity will affect seriously the parameter estimates. If multicollinearity turns out to be significant, the simultaneous presence of the two variables reinforces the individual effect of the variables. Therefore, the coefficients of the interaction of the variables indicate whether or not one of the two associated variables should be eliminated from the analysis. According to Gujarati (1995), there are various indicators of multicollinearity and no single diagnostic will give us a complete handle over the collinearity problem. Of various indicators of multicollinearity, Variance inflating factor (VIF), condition index (CI) and coefficient of contingency were used to check for multicollinearity problem among and between explanatory variables (Genene, 2006). Therefore, for continuous variables VIF and CI and for discrete variables coefficient of contingency were employed to check the colinearity effects among the variables. A VIF value greater than 10 and CC value greater than 0.5 is used as a signal for a strong multicollinearity (Gujarati, 1995). Therefore, VIF and CC can be defined as:

$$\text{VIF}\ (R_j) = \frac{1}{1-R^2}$$

Where R^2 - is the coefficient of determination when the variable X_j is regressed on the other explanatory variables.

$$\text{CC} = \sqrt{\frac{x^2}{N+x^2}}$$

Where x^2 - is Chi-square random variable and N- is total sample size.

The parameters of the model were estimated by using the iterative maximum likelihood estimation procedure. Because ML- yields unbiased and asymptotically efficient and consistent parameter estimates.

3.5 Definition of variables and working hypotheses

Dependent variable: The dependent variable for this study has dichotomous nature representing the preferred status of the farmers' decision to maintain conservation structures regularly. The variable takes the value 1 if the farmer is maintaining soil conservation structures regularly and 0 otherwise. The dependent variable is, therefore, hypothesized to be influenced by a number of factors which are stated below.

Independent variables: Based on theoretical background and empirical results of different studies on soil and water conservation activities, and other related natural resources conservation decision studies carried out in Ethiopia or elsewhere as well as considering the information from the informal survey and the researcher's knowledge of the conservation practices of the study area, the following variables are hypothesized to influence farmers' decision to maintain conservation structures on their fields that was already constructed by public campaign.

Sex of household head: This is a dummy variable which takes a value of 1 for male and 0 for female respondents. Literature indicates that female-headed households have less access to improved technologies, land and extension than male-headed households (Green, 1993). Therefore, it is expected that the male-headed households have better decision power to use introduced soil and water conservation technologies than female headed households.

Household head age: According to most of the previous studies, as age of a household head increases, he/she becomes reluctant to retain conservation structures at most. But some studies indicate that the old farmers use more soil conservation structure than younger farmers since younger farmers have small plots of land and they consider as lost of land in using of conservation structure. Hence, in this study it is hypothesized that age and decision to use and retain conservation structures to be correlated negatively.

Household size: This is number of household members living together. The influence of household size may go either way. As maintaining soil conservation structure is labor intensive, if household labor is the only source of labor, households with larger household size make decision to retain structures. On the contrary, in the families with large number of mouth to feed, most of household members can be engaged in other income generating activities and hence fail to make decision to maintain and retain conservation structures.

Educational level of the household head: This is educational attainment level of the household head. It is expected that those farmers with better educational attainment perceive the problem better and make decision to retain conservation structures. Thus, education level is hypothesized to influence decision of farming households to maintain conservation structures positively and significantly.

Farm size: This refers to total area of land a household cultivates measured in ha. Farmers having large farm size can bear risk of loss of cultivation land from conservation structures and hence expected to influence adoption of structures positively.

Source of land (land ownership): this is a dummy variable representing means by which a farmer accessed land (whether rented or owned). Farmers that rented land have short term planning horizon compared to those that own the land and hence may not be interested on long term benefit that can be obtained from conservation structures. Following this, it is hypothesized that source of land (owning land) is correlated to adoption decision positively.

Slope of the cultivation land: This is slope category of cultivation field according to how farmers in the study area categorize slope of the cultivation land. Soil erosion becomes intensified with increasing slope of the cultivation land and since farmers are more perceived the problem they are more likely to use conservation measures. Hence, it is expected that slope influences farmers' decision to retain conservation structures positively.

Perception of soil erosion: This is the degree of severity of soil erosion problem as perceived and rated by the local people. Most of previous studies indicated that perceiving the economic significance of soil erosion is a necessary condition and related positively with the decision of continued use of soil conservation structure. In this study it is also hypothesized to influence farmers' decision to retain conservation structures positively.

Participation in SWC works: It is a dummy variable that takes a value of 1 if households participate voluntarily and 0, otherwise. Thus it is hypothesized that this variable influences the decision to use and maintaining those of improved SWC technologies positively and significantly.

Effectiveness of SWC technologies: Most farmers in Ethiopia use traditional conservation measures such as furrows and diversion ditches. Previous research indicated that perception of the role of technology influences adoption decision. Hence, positive association is expected between technology attributes (retaining soil erosion and ensuring crop productivity) and decision to retain conservation structures.

Off-farm activities (off-farm): This is a dummy variable representing whether the household has involved in off-farm activities or not. Involvement in off-farm activities crowds out resources required to construct and maintain conservation structures. Therefore, negative association is expected between involvement in off farm activities and activities of conservation structures.

Contact with development agents: This is a frequency of contact between extension agents and farming households within a month. It was measured by number of contacts within a month; therefore, if the DA visits a farmer in every week, they perceive that a farmer has very good contact with the DA whereas those that are not visited well have poor contact. Households that have better contact and relation can have access to timely and adequate information and hence expected to correlate with conservation structure adoption decision positively and significantly.

Access to credit: It is a dummy variable, which takes a value of 1 if the farm household had access to credit and 0 otherwise. Access to credit is expected to have positive impact on adoption of introduced conservation measures, because if farmers get credit service their purchasing power increases and they can buy fertilizer even if its price is high.

4. RESULT AND DISCUSSION

This chapter discusses the descriptive and econometric analyses results of the study. The descriptive statistics results section includes discussions and descriptions about demographic, socioeconomic characteristics, institutional and biophysical characteristics with their influence on the continuity of soil and water conservation activities in the study area; whereas the econometric analysis sub-section discusses the impact of only the selected determinant variables that were hypothesized to affect the decision of farmers to use and maintain improved soil conservation technologies.

4.1 Descriptive statistics results

4.1.1 Household demographic characteristics and its impact on SWC activities

4.1.1.1 Age and Sex of respondents

Age of the household head was hypothesized to have an influential effect on the adoption of new agricultural technologies and particularly on the acceptance of soil and water conservation technologies. Among interviewed sample households the maximum and minimum age was found to be 75 and 25 years, respectively.

As shown in Table (1) below, the mean age of sample household heads was 45.36 with standard deviation of 11.36. The mean ages of sample household heads who maintaining SWC regularly and did not maintaining regularly were 43.83 and 46.20 with standard deviation of 11.24 and 11.42 years respectively. The mean age of household heads who decided to maintain SWC regularly was found to be less than that of household heads who decided to remove and not to maintain SWC regularly.

In the prior expectation, it was hypothesized that when age of the households was increased, their probability of accepting new technologies will be decreased. Therefore, the findings of the survey were in line with this expectation. This implies that younger farmers were more likely to maintain conservation structures regularly than older farmers.

However, the statistical analysis of t-test revealed that the mean age differences between the two groups of sample households were found to be insignificant.

Table 1: Distribution of sample household by age group

Age group	Maintain regularly (45)		No regular maintenance (75)		Total sample (120)		t– value
	No	%	No	%	No	%	-1.090
25-40	19	42.22	28	37.33	47	39.17	
41-55	18	40.00	32	42.67	50	41.67	
56-70	8	17.78	11	14.67	19	15.83	
>70	0	0.00	4	5.33	4	3.33	
Mean		43.87		46.20		45.36	
S.D		11.24		11.42		11.36	

Source: own survey, 2013

As shown in Table (2), the survey result indicated that among the total sample household heads, 75.83% were male and 24.17% of them were female. The survey result revealed that there is a significant difference at 1% significant level between male and female-headed household with respect to their decision to retain conservation structures.

It indicated that male-headed households were more likely decided to maintain conservation structures regularly than female headed ones. The possible explanation for this would be male headed households have better access to agricultural technologies and better access and control over land resource than female headed households; and it is consistence with the prior hypothesis.

The chi-square test for sex between the two groups was found to be significant at 1% probability level i.e. there is the relationship between sex and households decision status on the maintenance of constructed soil and water conservation measures.

Table 2: Distribution of sample households by sex

		Maintaining regularly(45)		Not maintaining regularly(75)		Total sample (120)		x^2
		No	%	No	%	No	%	6.696 ***
Sex of the respondent	Male	40	88.9	51	68	91	75.83	
	Female	5	11.1	24	32	29	24.17	

*** Significance at 1% level

Source: own survey, 2013

4.1.1.2 Family size of sample households

The family numbers of the sample households ranges from 1 to 9 persons, with a mean of 5.02 persons and standard deviation of 1.82. About 73 percent of the total sample households have a family size of 4 and above persons per household head (Table 3).

The average family size of households who maintained and did not maintain regularly was found to be 5.27 and 4.87 persons with standard deviation of 1.75 and 1.86, respectively. Family size was expected to have a great impact on the soil and water conservation efforts that carried on the study area. Hence, it was hypothesized that the more family number households own, the more they likely to maintain conservation structures on the plots of land because SWC works are more labor intensive; but the statistical analysis showed that the difference in the mean family number between the two groups was found to be insignificant.

This is in line with other studies conducted in Ethiopia indicated that in the large families with greater number of mouth to feed, immediate food need is given priority and labor is diverted to off-farm activities that generate food.

Hence, during SWC campaign season, opportunity cost of labor for the household with greater size will be higher (Wagayehu and Lars, 2003).

Table 3: Distribution of sample households by family size

Family size in number	Maintain regularly (45)		No regular maintenance (75)		Total (120)		t– value
	No	%	No	%	No	%	1.165
≤ 3	9	20	23	30.67	32	26.67	
4-6	25	55.56	36	48	61	50.83	
7-9	11	24.44	16	21.33	27	22.50	
Mean	5.27		4.87		5.02		
S.D	1.75		1.86		1.82		

Source: own survey, 2013

4.1.1.3 Educational status of respondents

The education level of household heads is expected to increase the ability of farmers to obtain, process and use of information relevant to the use of improved agricultural technologies in general and soil conservation technologies in particular. Concerning the educational level of sample household heads, the survey results indicated that about 58% of the total respondents were illiterates, while the rest 42% of the respondents had various educational levels ranging from the ability to read and write up to high school. As shown in Table 4, among the farmers who maintaining SWC measures regularly about 36% of them were illiterate; and among groups of farmers who did not maintaining conservation measures on their plots of land about 71% of them were illiterate too. Majority of farmers that removed conservation measures were attained lower educational status.

On the contrary, the majority of farmers that maintained conservation measures were those that attained the highest educational status and it showed an increasing trend with increasing educational attainment (Table 4). It can be justified as, in the study area, education influences farmers' decision to adopt technologies by enhancing their ability to obtain, understand and utilize the practice, and by improving their overall managerial ability as previous expectation.

The result of χ^2-test also has shown that significant difference for distribution of illiterate and literate household heads between the two groups at 1% significance level.

Table 4: Distribution of sample households by educational status

Educational status	Maintain regularly (45)		No regular maintenance (75)		Total sample (120)		x^2
	N<u>o</u>	%	N<u>o</u>	%	No	%	20.063***
Illiterate	16	35.56	53	70.67	69	57.5	
Read and write	20	44.44	21	28	41	34.17	
Grade 1-6	8	17.78	1	1.33	9	7.5	
Grade 7-12 and above	1	2.22	0	0.00	1	0.83	

*** Significant at 1% level

Source: own survey, 2013

4.1.2 Land characteristics and farming system

4.1.2.1 Total land holding and number of plots

The survey results showed that landholding size of total sample households ranges from 0.25 to 3.50 ha with a mean of 1.34 ha and standard deviation of 0.71. The average landholding size of the farmer groups that decide to maintain and not to maintain conservation structures were 1.42 and 1.29 ha with a standard deviation of 0.78 and 0.67, respectively. Farm size of most farmers (44%) falls between 0.25 and 1 ha. It was found that only about 10% of the sample households have a farmland of above two hectares (Table 5). There was a slight difference in the mean size of landholding between the two groups that shows as the size of cultivated land increases the probability of a household to implement and maintain conservation structure increases, which indicating that a household with more cultivated land has a capacity to avert a risk of land wasting due to physical construction of conservation measures. However, the result of t-test showed that the mean landholding size difference between the two groups was found to be insignificant.

This finding is not consistent with its prior expectation of significance influences of land size on the farmers' decision to construct and maintain conservation structures on their land.

Table 5: Distribution of sample household heads by total land holdings

Land size (ha)	Maintain regularly (45)		Not maintain regularly (75)		Total sample		t– value
	No	%	No	%	No	%	0.930
0.25-0.5	1	2.22	5	6.67	6	5	
0.5- 1	18	40	29	38.67	47	39.17	
1.1 – 1.5	11	24.44	11	14.67	22	18.33	
1.51 – 2	10	22.22	23	30.67	33	27.5	
> 2	5	11.11	7	9.33	12	10	
Mean (ha)	1.42		1.29		1.34		
S.D	0.78		0.67		0.71		

Source: own survey: 2013

The survey results showed that the average number of farm plots for total sample households and for those groups who maintaining and not maintaining conservation structures were 3.54, 3.82 and 3.37 with a standard deviation of 1.24, 1.09 and 1.29 respectively. As shown below, there are no that much decision differences between the two groups of farmers with different plots of land. But it was expected as when the plots are more fragmented, it would be difficult for management.

Table 6: Distribution of sample households by number of farm plots

Land plots number	Maintain regularly (45)		Not maintain regularly (75)		Total sample (120)	
	No	%	No	%	No	%
1	0	0	7	16.67	7	5.83
2	6	13.33	15	20	21	17.5
3	13	28.89	13	17.33	26	21.67
4	9	20	23	30.67	32	26.67
5 and above	17	37.78	17	22.67	34	28.33
Mean (no)	3.82		3.37		3.54	
S.D	1.09		1.29		1.24	

Source: own survey, 2013

4.1.2.2 Distance of plots of land

The distance of farm plots from residence is one of the factors that are expected to affect the use and the maintenance of soil conservation technologies. Thus, the mean distances for total farm plots were found to be 36.73 minutes with the standard deviation of 23.05. And also the mean distance of plots for household groups that decide to maintain and not to maintain conservation structures were found to be 32.84 and 43.22 with a standard deviation of 19.32 and 27.22 respectively. As shown below in Table 7, majority of sample households (69%) plot land distance were taken between 31 and 60 minutes. During focus group discussion, it was indicated that farmers having land far from their residence usually did not give visit and lacks regular and appropriate management. Especially after harvesting season, open and free livestock grazing on the field destruct and exploit those physical and biological conservation structures. This result in lots of spots destroyed which enhances runoff beneath the embankments.

As a result farmers were more likely to remove such conservation structures in plowing season since the collapsed structure aggravates erosion on cultivated land. Hence, farmlands situated far from residence suffer from destruction of conservation structures and may increase the severity of erosion. The result of t-test showed that the mean time taken difference between plots distances of the two groups was found to be significant at 5% level.

Table 7: Distribution of sample households by their average plot distances

Distance category (minutes)	Maintain regularly (45)		Not maintain regularly (75)		Total sample (120)		t– value
	No	%	No	%	No	%	2.242**
< 30	13	28.89	27	36	40	33.33	
31 -60	24	53.33	45	60	69	57.5	
61- 90	6	13.33	2	2.67	8	6.67	
91-120	2	4.44	1	1.33	3	2.5	
Mean(min.)	32.84		43.22		36.73		
S.D	19.32		27.22		23.05		

*** Significance at 5% level Source: own survey, 2013

4.1.2.3 Slope and soil type of the land

Slope is one of the physical characteristics of farm plots used as a proxy measure for the degree of erosion, which in turn affects the use of improved soil conservation measures. The response of farmers with regard to soil conservation structures showed difference among farmers cultivating different slope categories. Majority of sample households (52.5%) have flat lands, whereas 47.5% of the households have non-flat landscapes. As shown in Table 8, farmers have different decisions towards the maintenance of conservation measures constructed by public campaign on their own field, for instance, those farmers whose land was steeply sloping was more likely to be decided to use and maintaining conservation structures than farmers whose land is less sloping or flat land. However, the chi-square test showed that the influence of slope of land on the farmers' decision to maintain conservation structure between the two groups was found to be insignificant.

The soil type of the farm plots have also been identified as sandy, clay and silt. Majority of the households (57%) have lands with clay soils. Farmers with sandy soils mainly in lowland and fragmented agro-ecosystem zone of the study area were more tend to maintain conservation measures than other farmers whose land is other than sandy soil.

Table 8: Distribution of farm plots by slope category and soil type

Slope category	Maintain regularly (45)		Not maintain regularly (75)		Total sample		x^2
	No	%	No	%	No	%	2.450
Flat	22	48.84	41	54.67	63	52.5	
Gently sloping	8	17.78	12	16	20	16.67	
Moderately sloping	4	8.89	11	14.67	15	12.5	
Steeply sloping	11	24.44	11	14.67	22	18.33	
Soil type							
Sandy	6	13.33	9	12	15	12.5	
clay	25	55.56	43	57.33	68	56.67	
Silt	14	31.11	23	30.67	37	30.83	

Source: own survey, 2013

4.1.2.4 Sources of land (land ownership)

As shown in Table 9, the survey results shown that 90.83% of the respondents have their own plots of land for cultivation where as the rest of 9.17% of respondents' source of land is rented. The result of the survey revealed that among farmers that maintaining conservation structures regularly, 95.56% of them have their own plots of land and only 4.44% of farmers who rented land from other farmers were maintaining conservation structures. This result indicated that those farmers who use rented land have less interest to construct and maintaining conservation structures than other farmers who have cultivated their own lands. This was happened because of the sense of land ownership that the farmers who rented land have no long term planning horizon to invest on that land since the maximum period of renting is not more than two or three years but the benefit gained from conservation measure is not as such immediate.

And the x^2-test indicated that the influence of different land ownership on the farmers' decision on the maintenance of conservation measures between the two groups was found to be significant at 10% significant level.

Table 9: Distribution of sample households by land ownership

		Maintain regularly(45)		No regular maintenance(75)		total		x^2
		No	%	No	%	No	%	1.928*
Land ownership	Owned	43	95.56	66	88	109	90.83	
	Rented	2	4.44	9	12	11	9.17	

*Significant at 10% level

Source: own survey, 2013

4.1.3 Respondents' perception about land degradation and soil conservation measures

Farmer's perception about the existence of land degradation problem on their farm plots, causes of the problems as well as its consequences might make farmers to wake up to use improved soil conservation measures. The majority of sample household heads (85%) have perceived the problem of land degradation on their farm plots. From this, only 43.14% of households were maintaining soil conservation structures regularly. Among the groups of farmers who maintaining and did not maintaining conservation measures, only 2.2% and 22.67% respectively, were not able to recognize the land degradation as the main problem of agricultural production on their own lands.

This shows that perceiving the problem of land degradation and soil erosion problem is not always a guarantee to the use of improved soil conservation technologies. But it has high influence on farmers' maintenance decision; for instance, among 15 farmers who have no perception regarding to land degradation problem, only 1 farmer was maintaining conservation measures regularly and from groups of farmers who maintaining regularly almost 98% have perception about land degradation problem; moreover, the x^2-test indicated that the difference between the two groups with respect to perceiving the existence of land degradation problem on farm plots was statistically significant at 1% level.

Table 10: Distribution of sample households by their perception of land degradation

Perception about land degradation	Maintain regularly (45)		Not maintain regularly (75)		Total sample (120)		x^2
	No	%	No	%	No	%	9.220***
Yes	44	97.78	58	77.33	102	85	
No	1	2.22	17	22.67	18	15	

*** Significant at 1% level

Source: own survey, 2013

4.1.3.1 Level of soil erosion across Agro-ecosystem zones of the region

The use and regular maintenance of soil and water conservation technologies are highly depend on the farmers' perception level about the severity of erosion impacts on their agricultural products. Moreover, the perception levels of farmers regarding to soil erosion is likely to be different across different agro-ecosystem zones of the watershed region. As shown below in Figure 3, the survey results revealed that farmers lived in lowland and fragmented valleys, midland with sloping lands and hilly and mountainous highland were found to be more perceived and aware about the severity of erosion problem than farmers who are from other agro-ecosystem zones. Among farmers who perceived more in the whole study area, 69.5% were from these two agro-ecosystem zones and also among farmers who perceived low, only 4.3% was from these two agro-ecosystem zones- no individuals who perceived low in hilly and mountainous highlands zones of the study area.

This result indicated that farmers in different agro-ecosystem zones have different perception level about erosion severity, and also as shown and indicated in the above Table (10), when the farmers are more perceived about land degradation problem, the more they were tended to use and maintain soil conservation measures. The x^2-test result of the survey revealed that the perception levels of respondents across agro-ecosystem zones were found to be significantly different.

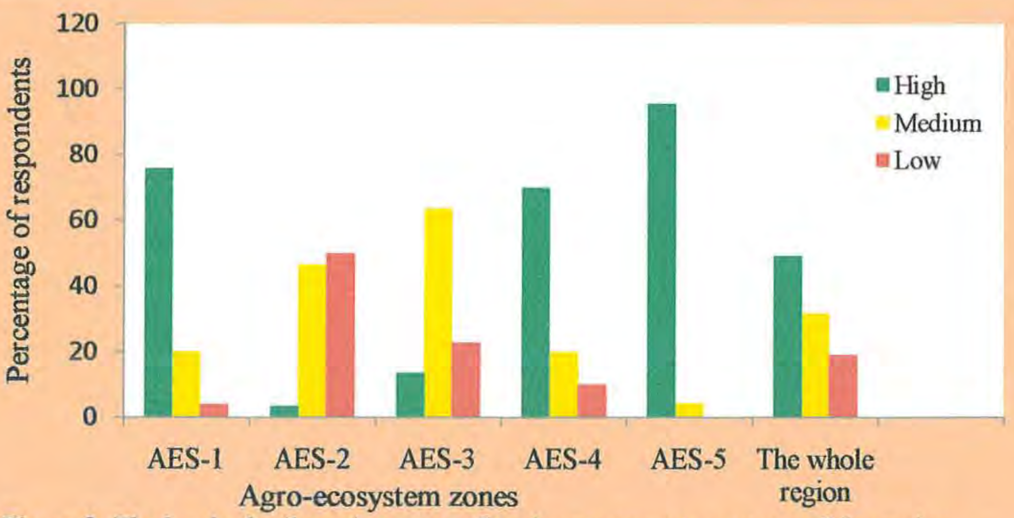

Figure 3: The level of soil erosion across five Agro-ecosysytem zones of the region

As shown in Table (11) below, among farmers who maintaining conservation structures regularly, majority of them (64.44%) have high perception about soil erosion problem. This indicated that farmers who perceived more about erosion severity were found to be adopted technologies easily than other farmers that they perceived low about the severity of the problem. Farmers will not be interested to invest in conservation and bear associated risks if they do not perceive significant about the threat posed on productivity due to soil erosion. And also statistically there is a significant relationship between perception of respondents and their decision to use and maintain soil conservation measures on their farm plots.

On fertile soil, erosion process does not affect farmers at least in the short term. The symptoms of erosion can be easily plowed away and on such sites there may not be a big effect on productivity of land, although the problem is recognized. Farmers cultivating such lands are reluctant to apply soil conservation measures. As the survey result (Table 11) revealed that about 52% of sample households cultivate lands with medium fertile lands and the rest 36% and 12.5% of respondents were cultivated low and high fertile soil lands respectively. But in this study the influence of fertility level on farmers' decision to use and maintaining conservation structures between the two groups were not significantly different.

About 78% of farmers that maintaining regularly perceived that introduced conservation structures to be more productive than traditional conservation structures (Table 11). Therefore, large proportion of farmers that perceived introduced conservation structures to be more productive than the traditional ones made decision to retain it properly and regularly. Hence, that is why about 78% of farmers that made decision to retain conservation structures on their cultivation field perceived that these structures to be more productive than traditional or lands without conservation measures.

This implies that once farmers perceive traditional conservation structures to be less productive, they look for more productive measures of conservation structures. But still majority of sample respondents (41%) were perceived that the crop productivity of the land were no change with and without conservation measures; however, during focus group discussion session the respondents were indicated that improved soil and water conservation technologies were somewhat reduce the level of erosion but the production did not changed, even, if there is some increment, it is due to the application of fertilizers and improved seeds than the effect of conservation measures alone.

The x^2-test showed as there is strong association between farmers' perception about the effectiveness of SWC activities on crop production and their decision on the implementation and regular maintenance of improved conservation structures.

Table 11: Perception of respondents on soil erosion level and on effectiveness of SWC on crop production

Perception of respondents		Maintain regularly (45)		Not maintain regularly (75)		Total sample (120)		x^2
		No	%	No	%	No	%	7.955**
Degree of erosion	Low	4	8.89	19	25.33	23	19.17	
	Medium	12	26.67	26	34.67	38	31.67	
	High	29	64.44	30	40	59	49.17	
Fertility level	Low	15	33.33	28	37.33	43	35.83	0.447
	Medium	25	55.56	37	49.33	62	51.67	
	High	5	11.11	10	13.33	15	12.5	
Crop production after SWC	Increase	35	77.78	6	8	41	34.17	62.675 ***
	No change	9	20	40	53.33	49	40.83	
	Decrease	1	2.22	29	38.67	30	25	

, * significant at 5% and 1% level, respectively

Source: own survey, 2013

4.1.4 Community Participation on soil and water conservation activities

In the study area, the major SWC work that we seen during our field observation were mainly focus on construction of physical conservation measures particularly stone and soil bunds, diversion ditches, water way, check-dams and trenches. The conservation effort is truly meritorious, but only if it is really effective and can be sustainable. To be effective, it has to be carefully engineered; and to be sustainable, genuine participation of stakeholders –the farmers- is imperative (woldeamlak, 2003). As shown in Table 12, only 41.67% of the interviewed farmers participated in the soil and water conservation campaign voluntarily or by their own willingness where as the rest of 58% of sample respondents were participated simply because they were forced to do so by the village administrator and development agents. As the survey result indicated that among respondents who maintain conservation structures regularly, 89% were participated in SWC works voluntarily; and from farmers that have not interest to maintain conservation structures, 87% were participated in the work by forced by local administrators and extension agents. This implies that volunteer and genuine participation of communities are a vital tool for adoption and sustainability of improved soil and water conservation technologies that disseminated to rural communities. Those farmers who participated by their willingness were more interested in the maintenance work of conservation structures than farmers who are forced to do without his internal interest. The statistical test also indicated that strong association between willingness of participation and farmers decision on the task of maintaining constructed soil and water conservation structures.

And also as shown in Table 12, the participation level of respondents at planning stage of SWC programs were found to be low (accounts 71.67%), only 3.3% of respondents were highly participated at planning stage of soil and water conservation programs. The x^2-test showed that the participation levels of respondents at planning stage between the two groups were also found to be significantly different. Therefore, it can be concluded that the methodology and mechanism of SWC intervention has to be formulated in the way that can encourage the genuine participation of the beneficiary population, which is an indispensable tool for sustainable management of natural resources.

This low community participation is reflected in the reluctance to maintain conservation measures and protecting natural resources. Farmers have being unwilling to take responsibilities for maintaining conservation activities on their own, unless they are told to do so and even sometimes want to be paid penalties for the construction and the maintenance which is a serious problem that should be tackled.

However, it is worth mentioning, the attempts being made to make the public aware of the problems of land degradation and motivate the participation in conservation activities in the country as a whole. Yet, more work will need to be done to empower the community, foster further their involvement, and encourage them to establish local regulations and bylaws, which guarantee conservation activities and achievements.

Table 12: Distribution of sample households by their participation on SWC programs

Participation on the SWC activities		Maintain regularly (45)		Not maintain regularly (75)		Total sample (120)		x^2
		No	%	No	%	No	%	
Participation willingness	Voluntarily	40	88.89	10	13.33	50	41.67	66.057***
	Forced	5	11.11	65	86.67	70	58.33	
Participation at planning of SWC	Low	17	37.78	69	92	86	71.67	53.281***
	Medium	24	53.33	6	8	30	25	
	High	4	8.89	0	0	4	3.33	

*** Significant at 1% level Source: own survey, 2013

4.1.4.1 Women participation

As shown in Table 13, 76% and 24% of sampled households were male headed and female headed, respectively. 76% of female headed respondents were take part in SWC works without their willingness and among voluntarily participated households; female headed households were account only 14% (Table 13). Therefore, female headed households most likely not to maintain conservation structures when compared to their counter parts - male headed households. The x^2-test result revealed that the participation level between male and female headed households were found to be significantly different.

Table 13: Women participation on SWC works

		Voluntarily		Forced		Total		x^2
		No	%	No	%	No	%	
Household heads	Male	43	47.3	48	52.7	91	75.83	4.834 **
	Female	7	24.1	22	75.9	29	24.17	
	total	50	41.7	70	58.3	120	100	

** Significant at 5% level

Source: own survey, 2013

4.1.4.2 Farmers' commitment to SWC works without any external support and influence

The sustainability of soil and water conservation technologies is highly relying on its social acceptability, economic productivity and profitability; and environmentally friendliness. But if the technologies lack either of the above pillar qualities, the communities will not be in the favor of accepting and applying it on their plot lands. As the survey result indicated in Table 14, majority of sample households (56%) have not plan and commitment to continue with SWC works if there is no external influence like influence of development agents, local administrators, other organizations effort and other incentives in kind or in cash that provided for them to their daily per diem of conservation work. The study result also showed that the more the farmers were committed, the more they maintaining conservation structures and the vice versa were true.

Among sample respondents that did not maintaining conservation structures, about 87% were had no plan and commitment to carry out modern conservation activities for the future. The difference in commitment between the two groups of household is statistically significant at 1% level.

Table 14: Distribution of sample households with their commitment to continue on SWC works

Farmers commitment	Maintain regularly (45)		No regular maintenance (75)		Total sample (120)		x^2
	No	%	No	%	No	%	
Yes	43	95.56	10	13.33	53	44.17	77.105***
No	2	4.44	65	86.67	67	55.83	

*** Significance at 1% level

Source: own survey, 2013

4.1.5 Institutional supports for SWC works

Agricultural and rural development minister in Ethiopia designed the extension system on the basis of a locally developed extension approach called the Participatory Demonstration and Training Extension System (Tesfaye, 1999), but much is still full of technical and methodological shortcomings leads to the limited success of the largest conservation programs in Ethiopia over the last few decades and even today. Access to extension service is the very important element of institutional support needed by farmers to enhance the use of agricultural technologies in general and soil conservation technologies in particular. Development agents were assigned in all sample villages and it was expected that all farmers in the study area have an access to extension services delivered by the DAs through preparing and organizing field days and different agricultural trainings.

However, as the survey results shown that about 37% of interviewed households have reported that they did not visited and have not gotten any extension services at least once in a month; and only 30% of sample households have a contact with extension agents every week. From groups of farmers that maintain conservation structures regularly, majority of them (62.2%) have contact with the agents every week; and from this group only 11% were not get contact at least once in a month. But majority of respondents (52%) who did not maintaining conservation structures were not get a contact in a month even once.

This result indicated that farmers seek good extension services to reduce uncertainty about conservation innovations. It is not expected the adoption of technologies from farmers who know nothing about the practice, unless they understand its expected costs and benefits. Accurate and timely information and training has a positive impact on farmers' decision of applying and maintaining conservation measures. More informed farmers are assessed better the impact of soil erosion on long-term productivity of their farmland and they tries to adopt practices that help to solve the problem (Fikru, 2009). The x^2-test result indicated that the frequency of extension agent visit to delivery extension services and training differences of the two groups was found to be statistically significant at 1% level (Table 15). This implies that the farmers who receive better information and training from extension agents are found to be more willing to construct new conservation measures and to maintain the existing installed conservation structures.

Also as shown below in Table 15, 47% of sample households were found access/use of credit and the rest 53% were have not access/use to credit. The finding of this work indicated that almost equal percentage of sample respondents from group of respondents who did not maintaining conservation structures were had access and had not access to credit i.e. 50.67% and 49.33, respectively.

And also the statistical test showed that credit and decision to use and maintaining of conservation structures have no significant association.

Table 15: Institutional factors that affect the sustainability of SWC technologies

Institutional support		Maintain regularly (45)		Not maintain regularly (75)		Total sample (120)		x^2
		No	%	No	%	No	%	
Extension agent contact	Every day	1	2.22	0	0	1	0.83	46.317***
	Every week	28	62.22	8	10.67	36	30	
	Twice in month	7	15.56	6	8	13	10.83	
	Once in month	4	8.89	22	29.33	26	21.67	
	No in one month	5	11.11	39	52	44	36.67	
Access/use of credit	Yes	18	40	38	50.67	56	46.67	1.286
	No	27	60	37	49.33	64	53.33	
Training	Yes	36	80	11	14.67	47	39.17	50.385***
	No	9	20	64	85.33	73	60.83	

*** Significant at 1% level

Source: own survey, 2013

4.1.5.1 Sources of information

As discussed so far in the above table, extension services play a vital role in bringing sustainable rural development through enhancing and transforming agricultural production by changing the awareness of rural communities from traditional production system to modern farming system; and to achieved this task, the role of extension agents over weigh at most in dissemination of accurate and on time information, technologies and giving different agricultural trainings to the farmers. But as the survey result showed in the figure below, only 50% of sample respondents were got information about SWC technologies and works directly from development agents, whereas, the rest 50% of respondents were get information from other sources other than extension agents.

This result indicated that there were information gaps between the two parties and this condition makes SWC works not to be effective as expected. The more farmers receives better information and training from extension agents, the farmer found to be more willing to construct new conservation measures and to maintain the existing installed conservations structures on their plots of land.

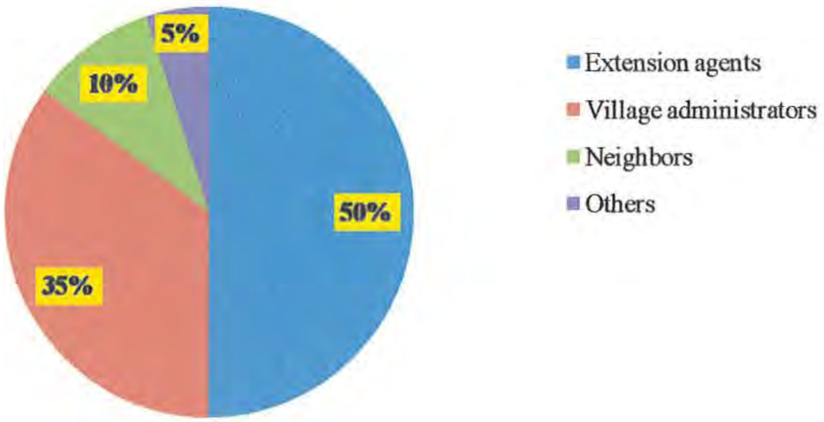

Figure 4 – Sources of information about SWC technologies and activities

Source: own survey, 2013

Note: Others is for respondents' response which is out of the above responses list

4.1. 6 Effectiveness of SWC works and crop production and productivity

The study area is characterized by mixed farming system in which crop production is one of the most important activities in the farming system. The major types of crops grown in the area include teff, wheat, barley and maize. In addition, sorghum is highly produced in the lowland and valley fragmented agro-ecosystem zones of the study area part. Survey result in Table 16, indicated that about 98%, 56%, 47%, 23% and 20% of the total sample households have grown teff, maize, wheat, barley and sorghum, respectively during the survey year.

Conservation is much more than a mere erosion control exercise but rather it has to have a wider scope of addressing productivity and production. Therefore, interviewed respondents were asked to evaluate the effectiveness of introduced soil and water conservation technologies in increasing crop production by comparing the production what they get in the same land size before and after the implementation of conservation structures; then after majority of the respondents (41%) were responded as there is no crop production change except decreasing erosion level a little bit and 34% were responded as increase and the rest 25% were responded as decrease (previous Table 11). But as shown below in Table 16, the statistical t-test result showed that all crop type mean production in quintal were found to be significantly different at 1% and 5% level before and after the implementation of conservation structures in the same plots of land.

However, during focus group discussion the participants were informed that the increment of crop production was not only due to construction of conservation measures but highly due to application of improved agricultural inputs mainly fertilizer (91% of respondent use fertilizer) and improved seed varieties. They were also indicated that crop production is highly depend on the nature of crop grown season that when there is normal rainy distribution and other climatic conditions, it is likely to get more production otherwise it may decrease as per of growing season is not favorable for the crop.

Therefore, the researcher would like to point out that such measure of effectiveness of SWC on crop production by itself is not strong enough unless we evaluate it by comparing the two groups based on baseline data and controlling other factors or variables. Because the below table result was found from the data that collected from the farmers by making them to recall and remember back the production what they get before SWC works, so some farmers may be given incorrect figures and that makes the researcher to lack confidence in drawing such conclusion.

Table 16: Crop production per unit area before and after SWC works measured by farmers view

Crop type	Cultivated land size (hectare)	Total Production before SWC (quintal)	Total Production after SWC (quintal)	No of respondent	%	t-value
Teff	72.51	721	749.5	118	98.33	
Mean	0.61	6.11	6.35			
S.D	0.47	4.22	4.24			-2.865***
Maize	15.64	395.95	411.75	67	55.83	
Mean	0.23	5.91	6.15			
S.D	0.12	4.34	4.38			-2.129**
Wheat	24	349	365	56	46.67	
Mean	0.43	6.23	6.52			
S.D	0.45	3.79	4.02			-2.468**
Barley	8.64	128.5	138.25	28	23.33	
Mean	0.31	4.58	4.94			
S.D	0.19	2.05	2.15			-2.173**
Sorghum	13.33	207	222	24	20	
Mean	0.56	8.62	9.27			
S.D	0.22	3.05	3.18			-3.292***

, * significant at 1% and 2% level

Source: own survey, 2013

4.1.7 Livestock production and management

Livestock as part of mixed farming system is having a paramount importance in the farming system and households' economy in the study area. Cattle, sheep, goat and equine are kept by farmers for income source, draft power and food (milk, meat). As the result shown below in Table 17, the total TLU of livestock owned by total sample households were found to be 631.08 TLU with the average of 5.3 TLU. From the survey result 91 percent of sample household heads own oxen with the average of 1.88 number of oxen. When we see the impact of livestock production on the soil and water conservation activities, it becomes one of the challenges for the sustainability of physical and biological conservation measures that installed on the field plots.

According to the response of key informants interviewed and discussions with development agents, livestock interference owing to the prevailing free grazing practices in the area is among the major limitations to sustainable management of soil and water conservation measures. Unlike the past time, nowadays a lot of efforts are tried to introduce a number of biological conservation techniques, but unfortunately suffered from the open grazing systems widely practiced in the study area and the country as a whole. On the contrary, traditional farming practices in some parts of the county, for instance in Konso, where livestock are stall fed, conservation practices are free from livestock pressure and as a result it gives expected outcome.

Therefore, in the absence of the willingness of farmers to take similar actions and the low commitment of government and NGOs to introduce improved livestock husbandry and management policies, conservation interventions would never be sustained, no matter to what extent, the technologies and techniques are efficient and effective, and the approaches are relevant and accepted.

Generally, currently open grazing of animals becomes the main problem and cause of destruction of physical structures and some agronomic measures; and also the problem is aggravated when the numbers of livestock owned by farmers are increased unless Strategies pursued to practice zero and control grazing.

Table 17: Total number of livestock holding by sample households

Type of livestock	Total number of livestock	Total TLU	Mean by number	Mean TLU	Number of respondent	%
Ox	226	226	1.88	1.88	109	90.8
Cow	182	182	1.51	1.51	98	81.7
Calf	127	31.75	1.06	0.27	84	70
Goat	165	21.45	1.38	0.18	32	26.7
Sheep	426	55.38	3.55	0.46	86	71.7
Donkey	129	90.3	1.08	0.75	85	70.8
Mule	1	1.1	0.01	0.01	1	0.83
Horse	21	23.1	0.18	0.19	19	15.83
Total TLU		631.08		5.3		

TLU = Stands for Tropical Livestock Unit

Source: own survey, 2013

4.1.7.1 Sources of animal feed

The survey results shown that all respondents (100%) who owned livestock were used communal grazing lands for the feed of animals, only 47.5% and 45.8% of sample respondents were had their own private grazing lands and hay feed, respectively (below Figure). It indicates that almost all farmers were highly depended on the communal free grazing land which may resulted for over grazing and the consequences of land degradation.

About 96% of sample respondents were also used crop residue as sources of animal seed which in turn damages the fertility of soils in the cultivated lands as well as it reinforces erosion further by wind and rainfall.

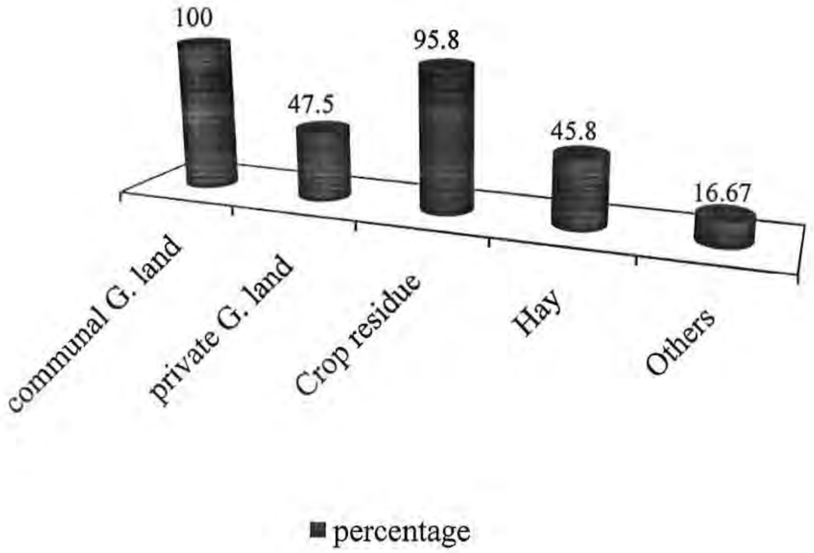

Figure 5 – Percentage of sample respondents by their source of animal feed

Note: Others is for respondents response which is out of the above responses list

Source: own survey, 2013

4.1.8 Causes of land degradation

Land degradation may occur due to different reasons either by human induced or natural causes. As shown in the figure below, there are different human induced cases of land degradation and the sample households were asked to identify the main causes of degradation in their lands.

Figure 6 – Severely degraded land in the study area (own photo at the field)

Farmers have also different perceptions regarding the causes of soil erosion problem. Deforestation, over grazing, over cultivation, poor agricultural practices and poor SWC installation were some of the major causes of soil erosion problem explained by the respondents, of which deforestation, over cultivation, poor agricultural and SWC practices and over grazing were took a great percentage of respondent's rankings, respectively.

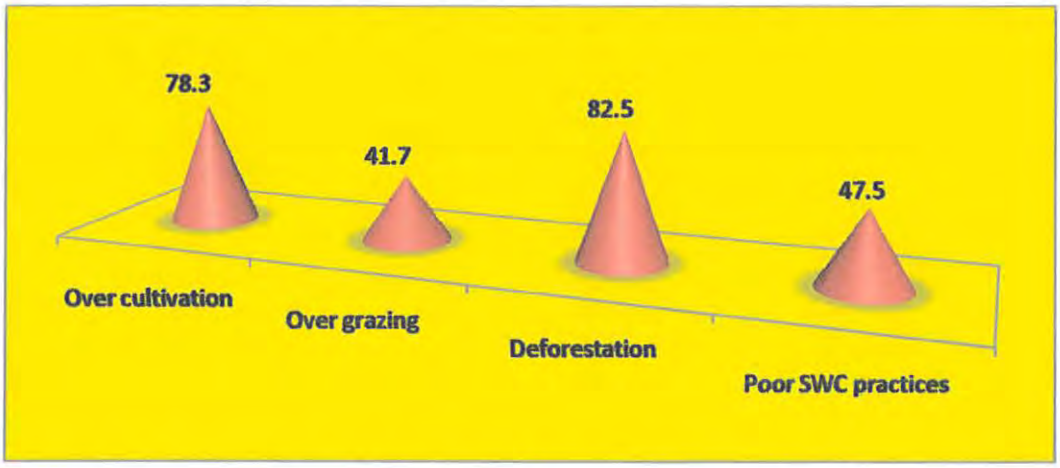

Figure 7: Responses of sample households on the human induced cause of land degradation by percentage

Source: own survey, 2013

4.1.8.1 Soil fertility maintenance activities

In order to increase the fertility level of soil and so as to increase agricultural products farmers in the study area were practiced different traditional and improved types of fertility maintenance activities. As the survey result shown in table 19, above 90% of sample respondents were used crop rotation and inorganic fertilizers (DAP and urea) but also majority of farmers have no a trend of land fallowing, tree planting, controlling of grazing of grazing lands and application of compost and manure. During focus group discussion participants were told that nowadays fertilizer is the main input for agricultural production in which without its application the crop production is almost nothing. But they were also indicated its expensive costs that they cannot get it with fair price, and also no enough amount and its delivery was not on time.

This was make them to face a lots of problem and they could not get good profit as expected compared to fertilizers effectiveness in increasing production. Furthermore, limited recycling of dung and crop residues to the soil was one of the main problems in soil fertility maintenance in the study area.

Table 19: Soil fertility maintenance activities applying by farmers

Soil maintenance activities	**No**	**%**
Land fallowing	28	23.3
Crop rotation	109	90.8
Compost and manure	51	42.5
Inorganic fertilizer	110	91.7
SWC measures	102	85
Tree planting	38	31.5
Control grazing land	27	22.5

Source: own survey, 2013

4.1.9 Description of Soil and Water Conservation measures introduced in the area

Different types of soil and water conservation measures were introduced to the study area. They were introduced with objectives of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production/ availability. Implementation of all soil and water conservation structures was limited to dry seasons (winter) so as not to interfere with crop production, to avoid difficulty of the work that arises from wetness of soil and to get more labor forces. Both traditional and improved soil conservation measures were under taken in the study area. The introduced soil conservation technologies include both biological and physical measures. The Conservation programs mainly targeted on farm lands, degraded lands (mainly on hillsides) and rehabilitate gullies. The physical measures widely introduced were stone bund, soil bund, fanya juu, waterway, cutoff drain and check dam. While the use of biological soil conservation technologies is very limited due to various reasons like, open grazing system and limitation of extension promotions were the major problems mentioned by extension expertise in the study area.

Soil/stone bund: These are embankments constructed from soil/stone along the contour with water collection channel or basin at its upper side. They 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 field which ultimately reduces and stops velocity of runoff. Usually they are constructed in fields that have slope less than
10%.

Fanya juu: is a Swahili term having meaning of throwing up-hill (Woldeamlak, 2003). These are embankments constructed by throwing the soil dug from basin to uphill. Like bunds, embankments of fanya juu terrace are laid following contour of fields. They are usually constructed in the fields sloping above 10%.

Figure 8: Fanya juu supported by grasses at the field (own photo)

Check dames: These are structures built across the bottom of a gully to reduce the velocity of runoff and prevent deepening and widening of the gully. They are constructed from rock and brush wood for gully control.

The height of these structures reaches up to 1 m depending on the gully width and have adequate spillway for safe disposal of water with apron at the foot of the check-dam to dissipate energy.

Figure 9: Gully rehabilitation by stone check dam (own photo at the field)

Cut off drain: It is used to collect run- off water from land above cultivated areas and divert it to safe discharge areas. This measure requires well designed artificial water ways to discharge the run- off and, also requires more labor to construct it. The channel dimension depends up on the area of the catchments, run off coefficient and the type of soil.

Figure 10: Construction of cut off drain during field observation (own photo at the field)

Artificial waterways: These are drainage channels down on the slope in which water is safely discharged. The combination of cutoff drains and waterways together with level bunds is very important for the successfulness of soil conservation measures particularly in the high land areas where there is high rain fall and run off.

Figure 11: Well constructed stone paved waterway (own photo at the field)

4.1.9.1 Traditional versus improved conservation measures

Among interviewed households in the study area, majority of the them (56.7%) preferred to use traditional conservation measures which is designed by their own experience and knowledge, whereas about 43% of them were chosen improved conservation structures which designed by outsiders Table (20). During the group discussion session the participants mentioned different problems as a reason to not chosen improved conservation technologies. Mainly wasting of land was raised as serious shortcoming of the technologies.

Table 20: Distribution of sample respondents by their choice of SWC measures

Choice of SWC measures	No	%
Traditional conservation practices	68	56.7
Improved conservation measures	52	43.3
Total	120	100

Source: own survey, 2013

4.1.9.1.1 Effectiveness of improved SWC measures compared to traditional measures

Farmers' decision to use and maintain constructed introduced conservation structures showed a difference with differences in the perception of the effectiveness of introduced conservation structures in arresting soil erosion and increasing crop production. 45% of interviewed sample households indicated that introduced conservation structures are as effective as or less effective than traditional conservation structures in controlling soil erosion; and majority of these farmers made decision to reject and not to maintain regularly those installed conservation structures. On the other hand, majority of farmers that maintained conservation structures regularly were indicated that these structures were more effective than traditional conservation measures. As shown in Table 21, about 67% of sample respondents were also indicated that the effectiveness of introduced conservation measures in crop production was no change rather their production was decreased due to land wasting for physical installation.

Therefore, the comparable percentage of farmers' perception about the effectiveness of introduced conservation measures when compared to traditional conservation measures forced their decision whether to maintain constructed structures regularly or not. The x^2 statistics test result revealed that farmers' view about the effectiveness of introduced conservation measures in retaining erosion and in increasing production between the two groups were found to be significantly different.

Table 21: Effectiveness of improved SWC measures compared to traditional measures

Effectiveness indicator		Maintain regularly (45)		Not maintain regularly (75)		Total sample (120)		x^2
		No	%	No	%	No	%	53.314***
Erosion control	Lower	0	0	27	36	27	22.5	
	The same	1	2.22	26	34.67	27	22.5	
	Better	44	97.78	22	29.33	66	55	
Crop production	Increase	34	75.56	6	8	40	33.33	62.878***
	No change	11	24.44	34	45.33	45	37.5	
	Decrease	0	0	35	46.67	35	29.17	

*** Significant at 1% level

Source: own survey, 2013

4.1.9.2 Constraints of adoption of introduced SWC measures

Regardless of a high level of positive attitude about soil erosion and soil and water conservation practices, many farmers have not constructed and maintained the conservation structures on their farms. Care for the physical structures and a range of complementary conservation practices were not observed in the study area. As shown in figure below, farmers were mentioned different problems regarding to practicing introduced conservation measures. As a result, about 65%, 46%, 26%, 30% and 63% stated that those conservation structures have a problem of wasting of farmland, difficulties to turn oxen during plough, harbors rodents and rats, poor construction of structures aggravate erosion problems and the requirement of large labor force during construction and maintenance activities, respectively, were the main problems raised by the farmers that make them against for introduced conservation structures.

Due to this problem many farmers in the study area were informed that improved SWC technologies' costs is overweigh its benefits and they practiced it since the development agent and local administrators were forced them to do so, unless they paid money for penalty or punishment.

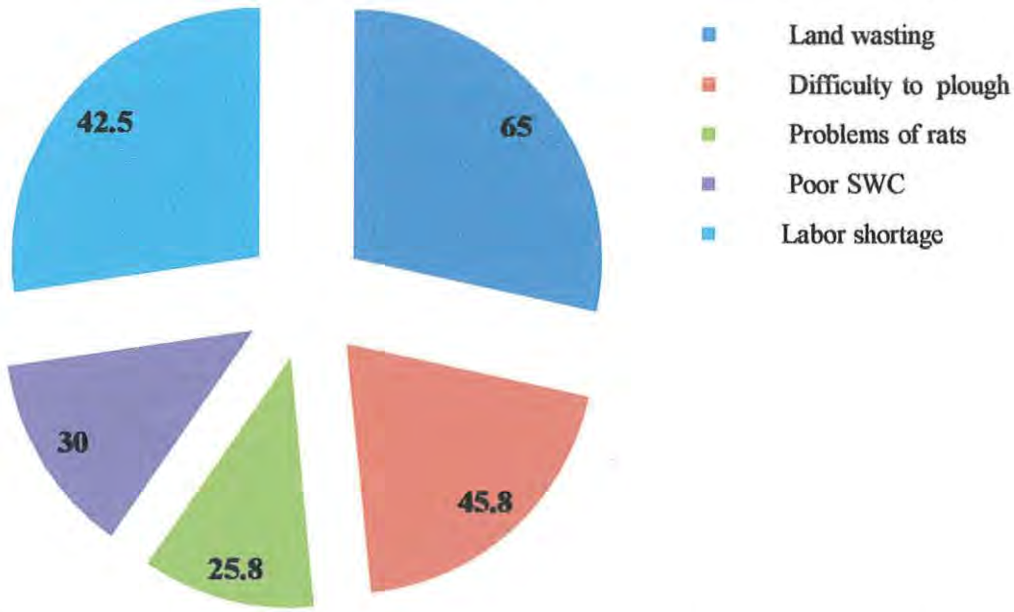

Figure 12: Percentage of farmers' reason to not adopt improved SWC technologies
Source: own survey, 2013

4.1.10 Impact of off –farm activities on SWC practices

One of the major interests of the study was to investigate if there was relation between farmers' decision of maintaining the introduced conservation structures and their involvement in off-farm income activities. Majority of farmers (69%) that did maintenance of structures were not involved in any of off-farm activities and also among the respondents from not maintaining conservation structures 68% were not involved in any of off-farm activities (table 22).

This result indicated that whether the farmers were involved in any of off-farm activities or not, it has not influences on their decision to use and maintain the constructed conservation measures on their fields. The statistics test also indicated that the association between off-activities and farmers' decision was found to be insignificant.

Table 22: Distribution of sample households by their involvement in off-farm activities

Involving in off-farm activities	Maintain regularly (45)		No regular maintenance (75)		total		x^2-value
	N<u>o</u>	%	N<u>o</u>	%	No	%	0.003
Yes	14	31.11	24	32	38	31.67	
No	31	68.89	51	68	82	68.33	

Source: own survey, 2013

4.2 Econometrics model result on determinants of farmers' decision to use and maintain soil and water conservation measures

In the preceding parts of this thesis the descriptive analysis of important explanatory variables that were expected to have impact on the decision of a given farmer to decide in maintaining SWC structures were presented. In this section also, the selected explanatory variables were used to estimate the binary logistic regression model to analyze the determinants of household's decision to use and retain conservation structures.

A binary logistic regression model was fitted to estimate the effect of hypothesized explanatory variables on the probabilities of decided to maintain conservation structures or not. Hence, Binary logistic regression model was used to identify potential socio economic, institutional and biophysical determinants that affected farmers' decision to use and maintain regularly those collectively constructed conservation measures. However, prior to the estimation of the model parameters, it is crucial to look into the problem of multicollinearity or association among the potential explanatory variables.

Multicolinearity diagnostics test was done to crosscheck the presence of high colinearity between each independent variable. There are different methods that were used to see the presence of multicollinearity for continuous and discrete explanatory variables. Variance inflating factor (VIF) and condition index (CI) were used to check for multicollinearity problem among and between continuous variables (Genene, 2006). Therefore, for continuous variables VIF and CI and for discrete variables coefficient of contingency (CC) was employed to check the colinearity effects among independent variables. Based on the results of the diagnostic tests for both discrete and continuous variables, no variable was found to be highly correlated with one or more of other variables (see Appendix Table).

Thirteen variables were hypothesized to affect and influence households' decision to use and retain constructed conservation structures on their plot lands. When all these variables were entered to the model, seven variables, namely education level, land ownership, slope of land, perception of erosion as a problem, willingness to participate, effectiveness of SWC technologies and contact of extension agent were found to be significantly different from zero coefficient and significantly affected farmers' decision whether to maintain or not to maintain and to remove conservation structures in the study area. The remaining six variables namely age, sex, family size, total landholding, off-farm activities and access/use of credit were found to have insignificant impact on farmers' maintenance decision in the study area. Among this six variables, four variables namely age, family size, total landholding and off-farm activities were found to have signs that was contrary to the prior expectation or hypothesis.

Table 23: The maximum likelihood estimates of the binary logistic regression model

Variable name	Estimated Coefficient (B)	Standard error (S.E)	Significance level (sig.)	Odds ratio Exp(B)
Age	0.069	0.050	0.168	1.071
Sex	0.162	1.090	0.882	1.175
Education level	1.884	0.898	0.036**	6.578
Family size	-0.143	0.255	0.574	0.866
Total landholding	-1.310	0.892	0.142	0.270
Land ownership	3.890	2.117	0.066*	48.933
Slope of land	2.786	1.269	0.028**	16.209
Perception on erosion problem	4.031	1.861	0.030**	56.295
Participation willingness	3.216	1.089	0.003***	24.929
Effectiveness of SWC	2.645	0.984	0.007***	14.080
Off-farm activities	1.911	1.189	0.108	6.672
Contact of extension agents	0.758	0.355	0.033**	2.134
Access/use of credit	1.456	1.013	0.150	4.289
Constant	-25.483	7.189	0.001***	0.000

Pearson chi-square_____________________ 110.522***

Hosmer and lemeshow test_______________0.991 (significance level)

-2 log likelihood________________________ 48.253

Prediction success - R^2 ____________________ 82[1]

Sensitivity [2] ____________________________ 91.1

Specificity [3] ______________________________ 93.3

Sample size______________________________ 120 households

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

1 – The success of prediction of the model based on a 50% probability classification table

2-- Correctly predicted households that maintaining SWC regularly based on a 50% probability classification

3-- Correctly predicted households that did not maintaining SWC based on 0.5 cut point probability table

Source: Binary Logit Model output

The maximum likelihood estimates of the binary logit model result shows that the sustainability of introduced SWC structures in the study area was influenced by different personal, socio-economic, institutional and biophysical factors.

To check measure of goodness of fit in logistic regression analysis, the likelihood ratio test that follows chi-square distribution can compute the goodness of fit of binary logistic regression (Gujarat, 2003). Accordingly, the chi-square computed result shows that, the model was significant at 1% significance level. This indicates that the null hypothesis stating the coefficients of explanatory variables are equal to zero was rejected and the alternative hypothesis of non- zero slope was accepted. And also the Hosmer and lemeshow test can show the goodness of fit of the model to predict the observed data fairly. Based on the test result the model was fitted to the data since the significance level is greater than 0.05 (which is 0.991).

Another comparatively simple measure of goodness of fit was the count R^2; and based on the calculated value it was found to be 82% (62 out of 75 for sample households who didn't maintaining SWC regularly and 37 out of 45 for sample households who maintaining SWC regularly were correctly predicted) that indicate the model correctly predicts the observed values. The sensitivity, the number of households that maintaining SWC regularly were correctly predicted by the model with 91.1% and the specifity, the number of households that didn't maintaining SWC regularly were correctly predicted by 93.3% observation. Thus the model predicts both groups of sample households fairly, appropriately and accurately. Those tested variables are explained well below here.

Sex: Sex of household head was found to be insignificant but positively related with farmers' decision of constructing and maintaining SWC structures in the study area. This implies that, other things remaining the same, male-headed households are seems more likely to adopt and maintaining conservation structures than female headed households but the difference is statistically insignificant and hence there is no sufficient reason to reject the null hypothesis that states coefficient of sex is not different from zero. But the previous studies like (green, 1993) were found a significant positive relationship between sex of the household and their decision to retain conservation measures. The possible explanation for this would be male headed households have better access to farmland, labor, agricultural technologies and better access and control over land resource than female headed households.

Age: Age of the household head was insignificantly but positively correlated with the farmers' retention and maintaining of conservation structures. Thus, older farmers are more likely to maintain conservation structures than their younger counterparts and it is contrast to prior expectation that older farmers usually have short term planning horizon and they may be less interested on long term negative effects of resources depletion and they are laggards to new technologies. The possible justification could be nowadays there is alarming population growth and the land holding size per individual tends to very low and the older farmers have relatively large farm size than the younger and those younger farmers mostly consider practicing conservation technology on their small plots as losing of productive land due to physical installation of conservation technologies. Due to this reason the older farmers can adopt better than young farmers. This result is in line with the finding of Fikiru (2008). However, other findings in different areas contrast this finding, for instance, Long (2003) and Wagayehu and Lars (2003) found negative and significant association between adoption of conservation structures and age.

Family size: This variable has insignificant effect on farmers' decision to maintain conservation measures. This implies that households having smaller size are not less likely to retain conservation structures than households having larger size since the coefficient of household size is not statistically different from zero even at 10% significance level. And also the coefficient has negative sign that shown households with smaller household size seem to decide to retain conservation structures than households with lager family numbers. This negative sign but the significant correlation is found to be in line with the previous studies by Wagayehu and Lars (2003). They found negative and significant association between adoption of soil conservation structures and household size. This might be because the large families with greater number of mouth to feed, immediate food need is given priority and labor is diverted to off-farm activities that generate income for household food consumption.

Education: Impact of education on farmers' decision to retain conservation structures was found to have a positive and significant relationship at 5% significance level. Holding other repressors constant, a change in household head education level by one unit, the probability of households' decision to retain conservation measures will be increased by a factor of 6.578. This positive and significant relation implies that the more educated farmers are more likely to make a decision to use and retain conservation structures than their counterparts with low level of education attainment. The justification of this finding was that education influences farmers' decision to adopt technologies by enhancing farmers' ability to obtain, understand and utilize the practice, and by improving overall managerial ability of farmers. This finding is also in line with the previous studies like (Long, 2003, Getachew, 2005, Derjaw, 2008, Etana, 1985) were found the significant contribution of education on the conservation efforts. But some previous studies, like Bekele (1998) found insignificant association between level of education and decision to retain conservation structures.

Farm size (landholding): Total farm size of the households was found to have insignificant relation with the maintenance of soil conservation measures. Hence, there is no sufficient evidences to reject the null hypothesis and can be concluded that farmers having small farm size are not less likely to retain conservation structures than their better landholding counterparts. Contrast to the prior expectation, its coefficient has negative sign indicated that the less farm size the farmers owned seems the better to maintain conservation measures than the farmers who have large farm size. It may justified as the farmers who have small cultivated land were more control their land and they did not want to bear or avert the risk of reduction in production due to erosion problems. Therefore, in the study area small landholders are more sensitive to erosion problems and they seemly more likely to implement and maintain conservation structures than those farmers who have large cultivated lands. But the difference was insignificant. This finding is contrast to the findings of Aklilu (2006), he found and reported that farmers who hold large farms were found to be more likely to invest in conservation technologies.

Land ownership: This variable have a significant correlation with the retaining of conservation structures at 10% significant level. The estimated coefficient was also positive as the prior hypothesis; this implies that farmers are more likely to invest in their own lands than the rented lands. This can be explained by the fact that the type of source to land (inherited or rented) were highly affect the planning horizon of farmers because as it is known the benefit gained from conservation activities is not immediate but the period of time for renting land to be managed by the farmer is most probably not more than a maximum of two years and hence farmers who cultivated rented lands were less likely to invest their time, labor and money for soil and water conservation works on such lands. Therefore, as they lack stake in long-term productivity of land they cultivate, they have strong preference for current income at the expense of long-term conservation investment and hence they are more harmful to the land. In owner-operated farms, in which a farmer has a personal stake in lands' sustainability, he farms harmoniously with nature and be concerned for his next children life and neighbors and future generations (Long, 2003). The finding is similar and consistence with previous work reports of Holden et al (2002) and Fikiru (2009).

Slope of land: As prior expectation, slope of land was associated and related with retaining conservation structures positively and significantly at 5% significance level. Holding other variables constant, a unit increase in slope of land from flat to very steep, the probability of farmers to maintain conservation structures will increase by a factor of 16.209 i.e. the odds of farmers that cultivated sloping lands are 16.209 times more likely to maintain structures than the odds of farmers who cultivating flat lands. This implies that farmers cultivating sloping and erosion vulnerable fields are retaining conservation structures better than farmers that cultivate lower sloping and less erosion vulnerable fields. It can be concluded that farmers were found to take SWC practices more seriously when they are cultivating steep land, for instance, farmers in Konso area started a unique SWC system because their landscape is dominated by steep slopes (Tesfaye, 2003). Therefore, slope has a significant influence on the farmers' decision to construct and maintain conservation structures on their cultivated fields. This is consistent with other studies undertaken in different parts of Ethiopia (Bekele, 1998; Wagayehu and Lars, 2003; Aklilu, 2006; Fikiru, 2008) were reported the positive association between slope and farmers' decision to adopt and retain conservation structures.

Perception of erosion: perception of erosion as a problem was found to be significantly and positively related to maintaining constructed conservation structures on their cultivated field at 5% significant level, which is similar to our previous expectation. This shows that the better the farmer perceives the problem of soil erosion, the more likely the farmer is to construct and retain conservation structures. By keeping other regressors constant, the odds of a farmer who perceived soil erosion better has the probability to maintain conservation structure 56.295 times the odds of farmers who perceive less. This variable affects the decision of farmers to use soil and water conservation technologies in which farmers who perceive more about the severity of erosion problems on their agricultural production and natural environments are more likely to be sensitive and to have better intention of mitigating the problem through adopting the technologies. This finding is also in line with and supported by other previous studies like (Bekele, 1998).

Participation willingness: The effect of participation willingness during public campaign work of improved soil conservation structures on the maintenance decision of farmers was found to be positive and significant at 1% significance level. This implies that farmers participated in SWC work voluntarily were found to be maintained constructed conservation structures regularly more than farmers who participated in works of conservation without their willingness by forced with village administrators and development agents. It can be concluded that by holding other explanatory variables constant, the probability odds of voluntary participated farmers to retain conservation structures will be 25 times the odds of those coercively participated farmers. This finding is similar to the finding of Woldeamlak (2003) that conducted in chemoga watershed.

Effectiveness of SWC technologies: The effectiveness of conservation technologies in retaining soil erosion and in enhancing crop production was found to be the main determinant factor in the in the farmers' decision of adoption and retaining conservation structures. Hence, its association with maintaining conservation structures was positive and significant at 1% significance level and the sign of the coefficient was similar to the prior expectation. By keeping other variables constant, farmers who perceived the existing conservation technologies are more effective in reducing erosion and in increasing production were maintain conservation structures 14.08 times higher than farmers who perceived as the technologies are the same or less effective than the traditional conservation measures. This implies that the more the farmers perceived as the technologies were more effective than the traditional one, the more they were maintained conservation structures regularly.

Off-farm activities: The effect of Off-farm activities on conservation activities was found to be insignificant but the sign of the estimated coefficient was positive which was contrary to the previous expectation. Even if, its impact is not significant, farmers having better access to off-farm activities were likely to invest on soil conservation activities than farmers who did not involve in any of off-farm activities.

Contact of extension agents: Frequency of extension agent contact was found to affect farmers' decision to use and maintain improved soil conservation structures positively and significantly at 5% significant level. By keeping other explanatory variable, increasing the frequency of contact by one term in a month, the probability of farmers to maintain conservation structures will be increased by a factor of 2.134. Every contact of the farmer with the development agents increased the probability of retaining soil conservation technologies. This can be justified as the farmers who have more contact with extension agents would get the necessary information and training that make them to acquire new skills and knowledge about agricultural technologies and specifically about conservation technologies. The close contact with extension agents makes accurate and timely information easily available to farmers. Previous study conducted in Ethiopia by Wagayehu and Lars (2003) were indicated that if there is close contact with the extension agents, the farmers are more likely to receive better information and advice from extension agents and they tend to be willing to construct new conservation measures and to maintain the existing installed conservation structures.

Access/use of Credit: Access to credit was expected to have positive and significant impact on adoption of introduced conservation measures in the study area, but contrary to this hypothesis, in this study it was found to affect the retaining of conservation structures insignificantly. Despite of its insignificant effect, its sign was similar to our expectation that implies if farmers get credit services, their purchasing power of agricultural inputs are more likely to be increased.

The most important issue with respect to access to credit is its link with land management; i.e. is credit used for hiring extra labor, purchasing fertilizers or other inputs; if it is used for other purpose this incentive is done nothing for the sustainability of soil and water conservation practices. Therefore, mere access to credit does not guarantee for proper land management as credit could be used for consumption. In this connection, some studies reported that increasing the amount of credit brought on a slightly to medium significant negative effect on the willingness of farmers to maintain SWC structures and they noted that such unusual results regarding credit occurred because the conservation technology was labor intensive rather than capital intensive, hence cash constraint plays a minor role in the SWC efforts undertaken.

5. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Based on the data collected from the study area, this research presented important information, justification and findings concerning conservation efforts made in the area. The survey result of this paper indicated that only 37.5% of sample respondents were maintaining constructed conservation measures regularly whereas the rest majority of them (62.5%) were either removing after just mass construction of the structure or have no interest to maintain it regularly.

The descriptive results showed that, the majority of the sample household heads (81.36%) have perceived the problem of land degradation on their farm plots. From this, only 43.4% of household heads were maintaining conservation structures regularly, whereas the rest of 56.6% were either removed the physical soil conservation structures or did not maintaining it regularly. This shows that perceiving the problem of soil erosion problem is not always a guarantee to the use of improved soil conservation technologies. The findings also indicated that the perception levels of respondents across different agro-ecosystem zones were significantly different, for instance, farmers who were in hilly and mountainous highland (Debre kelemo) and lowland with fragmented lands (Kurar) were more perceived about the severity and problem of soil erosion than farmers who lived in midland plains of the study area. As a result, those farmers who were more perceived erosion problem were more likely to use and maintain conservation structure on their cultivated land than farmers who lived in midland plains like Mahiber Birhane village, in which only 3.3% of them were perceived as the problem of soil erosion was high. Generally, the findings of the study show that even if, the majority of the sample household heads have perceived the problem of soil erosion on their farm plots, but their decision and effort to construct and maintain conservation measures were found to be very less.

This study also has tried to assess and look into the level of community's participation on the SWC programs and activities which can affect the farming households' decision to use and retaining different introduced conservation structures on their own plots of land. In the study area, the major SWC work that we were seen during our field observation were mainly focus on construction of physical conservation structures particularly stone and soil bunds, diversion ditches, water way, check-dams and trenches. The conservation effort is truly meritorious, but only if it is really effective and can be sustainable. To be effective, it has to be carefully engineered; and to be sustainable, genuine participation of stakeholders mainly local communities would mandatory. Farmers are not expected to approve and apply pre-designed trials but participate proactively on all aspects of the decisions that affect their livelihoods. As the evidences from the descriptive analysis indicated that the participation level of respondents at planning stage of SWC programs were low (accounts 71.67%), only 3.3% of respondents were highly participated at planning stage of soil and water conservation programs.

This implies that when the farmers were not active participant of program design, they may tend to develop a sense of externality for the programs that undertaken even on their own land. Regarding to participation during actual implementation of SWC works, only 41.67% of the interviewed farmers participated in soil and water conservation campaign voluntarily or by their own willingness where as the rest of 58% of sample respondents were participated simply because they were forced to do so by the village administrator and development agents. As the survey result indicated that among respondents who maintain conservation structures regularly, 89% were participated in SWC works voluntarily; and from farmers that did not interest to maintain conservation structures, 87% were participated in the work by force of local administrators and extension agents. Hence, those farmers who participated by their willingness were found to be more interested in the maintenance work of conservation structures than farmers who are forced to do without his internal interest. This implies that volunteer and genuine participation of communities are a vital tool for adoption and sustainability of improved soil and water conservation technologies that disseminated to rural communities.

As discussed earlier, a range of conservation measures were introduced in the study area with the objective of conserving, developing and rehabilitating degraded agricultural lands to ensure the food security status of local communities through retaining soil from erosion and bringing a consequence result of increasing food production and availability. Therefore, farmers' decision to construct and retain conservation structures were highly influenced by the effectiveness of delivered conservation technologies in its ability to control soil from erosion and its performance to increase crop productivity per unit area. Farmers who perceived and observed introduced soil conservation structures to be more effective in retaining soil erosion and ensuring sustainability of yield per unit area were made a decision to regularly maintaining conservation structures. This implies if farmers observed that the traditional measures they were used going to be ineffective in maintaining the productive capacity of land, they will seek and look forwards to the improved conservation measures to enhance productivity of the land and at the end of the day to ensure their food security.

As the descriptive statistics results indicated that among interviewed respondent households, majority of them (55%) were responded as the introduced soil and water conservation were better than traditional measures in protecting and conserving soil from erosion; but also among interviewed household regarding to its effectiveness in crop productivity per unit area, majority of them (38%) were responded that as crop productivity per unit area was no change even after application of improved conservation technologies and only 33% of them were indicated that the introduced conservation technologies were increased the crop productivity per unit area compared to those unit areas which have not any conservation structures or even with traditional measures. Hence, conservation technologies and practices must be evaluated by both technicians and farmers in terms of conservation potential, productivity and trial-ability. Technologies need to be sound and reasonable to reach a high level of acceptance.

In order to identify determinant factors that influencing farmer's decision to use and maintaining improved soil conservation technologies, a total of 13 explanatory variables were included to be analyzed by binary logistic regression model. The result of the analysis indicated that among these hypothesized explanatory variables included in the model, seven variables were found to be significantly affecting the probability of maintaining soil conservation structures in the study area at 1%, 5% and 10% significance level.

Education level of the farmers was found to have a positive and significant impact on their decision to use and maintain constructed conservation structures on their land. The results of the study revealed that the more educated farmers are more likely to make a decision to retain conservation structures than their counterparts of farmers with low educational attainment;

because education influences farmers' decision to adopt technologies by enhancing their ability to obtain, understand and utilize the practice, and by improving their overall managerial ability.

Source of cultivated land whether it is inherited or rented was also affected the retaining of conservation structures significantly. Farmers who cultivated rented lands were less likely to invest their time, labor and money for soil and water conservation works on such lands. Moreover, slopes of the land were found to have a significant influence on the farmers' decision to construct and maintain conservation structures on their cultivated fields. Farmers cultivating sloping and erosion vulnerable fields were perceived more about the severity of erosion and they were tending to retaining conservation structures better than farmers that cultivate lower sloping and less erosion vulnerable fields. Hence, farmers were found to take SWC practices more seriously when they are cultivating steep lands; for instance, the Konso community can be critical evidence in which they started a unique SWC system because their landscape is dominated by steep slopes (Tesfaye, 2003).

Perception of erosion as a problem was found to be significantly and positively related to farmers' decision to maintain constructed conservation structures on their cultivated field. This shown that the better the farmers perceived the problem of soil erosion, they were more likely to construct and retain conservation structures regularly on their own plots of land.

The effect of participation willingness during public campaign work of SWC on the maintenance decision of farmers was found to be positive and significant at 1% significance level. However, the result of this study indicated that the majority of the farmers considered SWC works that were undertaken in their communities to be mandatory development works in which the village administration and development agents forced them to participate. This suggests that the practice was not respect the principle of participatory approaches of development programs particularly the planning stage of SWC program was followed almost the conventional top-down type in which local communities were isolated actors and their interest and feelings were not considered.

The other most important factor that discouraging the farmers from participating voluntarily in SWC works was found to be associated with the effectiveness of SWC techniques and technologies by itself in reducing erosion and in increasing productivity per unit area. Therefore, the association between technologies effectiveness with maintaining conservation structures was found to be positive and significant at 1% significance level. This implies that farmers who perceived the existing conservation technologies are more effective in reducing erosion and in increasing production per unit area were maintain conservation structures better than farmers who perceived as the technologies are the same or less effective than the traditional conservation measures.

Frequency of extension agent contact was also found to affect farmers' decision to use and maintain improved soil conservation structures positively and significantly at 5% significant level. This can be justified as the farmers who have more contact with extension agents would get the necessary, on time and accurate information and training that make them to acquire new skills and knowledge about agricultural technologies specifically about conservation technologies. But in the study area the role of agricultural extension agents in promoting adoption of soil conservation was weak and as a result only 50% of sample respondents were gotten information and advice from the agent directly. And also some extension agents were not interested and committed to their work and they were indicated their reason that the work by itself has hardship and the payment what they get was low and education opportunity also almost null: hence these conditions were making them very discouraged for their work.

Whereas age of the household, sex, family size, farm size, off-farm activity and access/ use of credit were found to be less important factors in determining and influencing farmers interest towards soil and water conservation activities.

Livestock production is an important component of the farming system in the area since farming is integrated with crop and livestock production. However, livestock holding and management system affects the sustainability of physical soil conservation technologies at the field negatively. According to the response of key informants interviewed, livestock interference owing to the prevailing free grazing practices in Ethiopia is among the major limitations to sustainable management of soil and water conservation measures.

5.2 RECOMMENDATION

Important recommendations which were found to be of paramount importance from the findings of this study were suggested and forwarded for concerned bodies to the attainment of sustainable soil and water management activities which include:

- Education is very important determining factor that show positive and significant impact to retain conservation structures by creating good awareness and perception in the minds of farmers about the severity of erosion problem and the importance of different soil conservation technologies in the study area. Thus government has to give due attention for training of farmers by focusing on the severity of erosion, benefits of conservation and techniques in designing and constructing conservation structures through establishing and strengthen both formal and informal type of framers' education, farmers' training centers, technical and vocational schools.

- Perception of soil erosion problem has positive influence on farmers' decision to adopt conservation structures as it is positively and significantly related to adoption. This implies once farmers perceive the problem very well they are more likely to respond to it by employing soil conservation structures. Hence, they have to be provided with adequate information about the problem by development agents through training and other accessible media.

- Participatory approaches are much more likely to support the continuity and long-term adoption of SWC technologies. By promoting collective actions, using local knowledge and recognizing landholder's interest; farmers can be developed a sense of co-managers of their own natural resources. Then, it creates a chance of a durable change in farmer's conservation attitude which is much more important in sustainability of technologies. Therefore, methodology and mechanism has to be formulated that encourages the genuine participation of the beneficiary farmers at all levels of conservation intervention programs including at the planning stage, which is an indispensable tool for sustainable management of natural resources.

- The extension visit was an important variable affecting the probability of adopting improved soil conservation technologies positively. Therefore, to sustain the positive contribution of the extension service, Bureau of Agriculture should strengthen the extension contact through deploying adequately trained development agents with different department of specialization in adequate numbers to the farmers that could increase the contact as well as flow of information between the DA and the farmer.

- Effectiveness of conservation technologies is the crucial element to go beyond the short-term utilization of SWC measures and to promote a durable change in the management of the land. Therefore, the profitability of SWC measures for the farm household is one common and important factor for continued adoption of the technologies; because profitability of the conservation technologies is often regarded as a necessary condition for their adoption. Although farmers might be concerned by mid-term effects of erosion or by the social costs of land degradation, their decision to invest or not in SWC practices is still dominated by economic considerations. Thus, for potential long-term adoption of SWC measures, the concerned bodies have to be providing technologies by considering their appropriateness to the specific socio-economic, cultural and bio-physical circumstances and the economic profitability of the technologies.

- Based on our field observation most of conservation structures constructed in the study area were dominated by physical conservation measures alone. Therefore, to be sustainable, soil and water conservation programs and activities have to be integrated physical conservation measures with appropriate biological conservation methods.

- The farming households in most parts of the study areas are characterized by cultivating and settling with steeply slope landscapes; and also slope of the plots were found to be significantly and positively related to land degradation. Therefore, appropriate land-uses should be widely promoted to enable the plot for sustainable use and ensuring the household food security rather than intensive cultivation and settlement on steeply sloping lands.

- Livestock production and management system affects the sustainability of physical and biological soil conservation technologies at the field negatively. Thus, development agents at the frontline are advised to create an awareness about this situation to the beneficiary communities and persuade them to exercise zero grazing and controlled grazing methods; particularly, farmers that own relatively large number of livestock must get information and training on long term impacts of soil erosion due to over grazing and its impact by destructing conservation structures at the field due to free grazing system especially after crop harvesting season.

- Sometimes soil and water conservation activities are became a matter of political issues in which administrators and development agents are considering only quantity rather than quality of the work for the sake of report paper only. Hence, politicians and development agents are advised to be committed and pay more attention for maintaining the quality of SWC structures at the field. This means that conservation structures at the field would need to be properly laid out and built according to the standards given in the guidelines and manuals. It is desirable to have few hectares of well constructed terraces than to construct thousands of hectares with low quality terrace which disappear soon after construction. Because, poor quality conservation activities cause more harm than the advantages they give.

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7. APPENDIX- I

Appendix table 1 - Contingency Coefficient for discrete variables

Variables	sex	Education	Slope	Land ownership	Perception	Participation	Effectiveness	Off-farm activity	Extension contact	Credit
sex	1	0.289	.009	0.044	0.143	0.197	0.286	0.169	0.187	0.280
Education		1	.176	0.086	0.084	0.359	0.294	0.147	0.393	0.201
Slope			1	0.128	0.208	0.175	0.147	0.057	0.163	0.020
Land ownership				1	0.132	0.092	0.111	0.220	0.063	0.050
Perception					1	0.252	0.259	0.123	0.300	0.166
Participation						1	0.451	0.015	0.481	0.045
Effectiveness							1	0.073	0.485	0.110
Off-farm activity								1	0.166	0.169
Extension contact									1	0.221
Credit										1
Remarks: Less Collinearity among Variables										

Source: Model output

Appendix table 2 - Variance Inflation Factor (VIF) and Condition Index (CI) for continuous variables

Variables	**VIF**	**CI**	**Remarks**
Age	1.231	5.294	Less collinearity
Family size	1.167	6.867	Less collinearity
Farm size	1.392	12.098	Less collinearity

Source: Model output

Appendix table 3 – Description of explanatory variables

Variable name	Variable definition	Unit of measurement	Types of variable	Expected sign
Sex	Sex of HH head	1 if male, otherwise 0	Dummy	+
Age	Age of HH head	Years	Continuous	-
Education	Education level of HH head	1 if illiterate,2 if read and wite,3 if elementary,4 others	Discrete	+
Family size	Family size	Number	Continuous	+
Land size	Land size of HH	Hectare	Continuous	+
Slope	Slope of the land	0 if flat, 1 if sloppy	Dummy	+
Land ownership	Source of land for HH head	1 if owned, 0 if rented	Dummy	+
Perception	Perception of soil erosion problem	1 if HH perceived, otherwise, 0	Dummy	+
Participation	Participation of HH in SWC works	1 if voluntarily, 0 if forced	Dummy	+
SWC effectiveness	Effectiveness of SWC technologies in crop production	1 if decrease, 2 if no change, 3 if increase	Discrete	+
Off-farm activities	Involvement of HH in off-farm activity	1 if involved, otherwise 0	Dummy	–
Extension contact	Frequency of contact of HH	1 if no cotact,2 if once in month,3	Discrete	+

	with the extension agent	twice,4 every week,5 every day		
Credit	Credit taken by HH	1 if they take, otherwise 0	Dummy	+

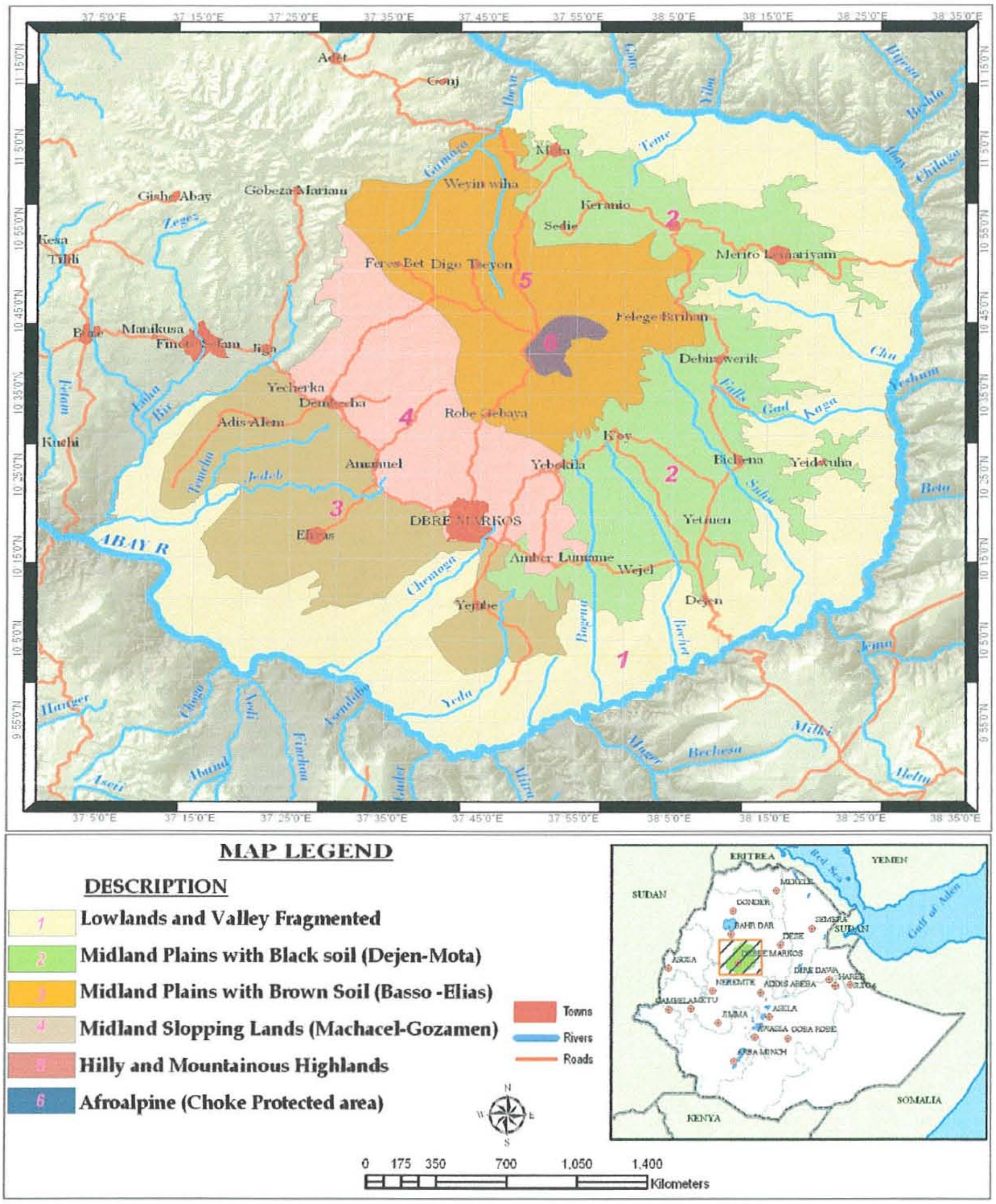
Appendix table 4. Conversion factors used to compute tropical livestock units

Animal type	TLU equivalent
Ox	1
Cow	1
Calf	0.25
Sheep	0.13
Goat	0.13
Donkey	0.7
Mule	1.1
Horse	1.1

Source: Strock et al., 1991

Appendix table 5- Sample household selection procedure

Agro-ecosystem zone	**Kebeles**	Sample households
Lowland and valley fragmented	kurar	25
Midland plains with black soils	mahiberbrhan	30
Midland plains with brown soil	Yemezegn	20
Midland slopping lands	Enerata	22
Hilly and mountainous highland	debrekelemo	23
		Total =120



Source: Belay Simane, 2013

Figure 1 - Six agro-ecosystem of Choke Mountain Watershed

APPENDIX- II Household survey questionnaire

General information

Questioner Number: ___________

Date of interview: Day _______ Month ___________ Year ___________

Interviewed by: ____

Data Entered: Day ____________ Month ___________ Year _________

Entered by: __________________

Region: ____________________

Zone: ______________________

Woreda: ____________________

Kebele: _____________________

Household Number: ________________

General information

1. Respondent name________________________

2. Sex 1. Male
   2. Female

3. Age_______ years

4. Marital status: 1. Single
   2. Married
   3. Divorced (separated)
   4. Widow

5. Size of the household ____________________

6. Educational level: 1. Illiterate
   2. Can read and write
   3. Grade 1-4
   4. Grade 5-8
   5. High school
   6. Diploma holder and above

Part I- Biophysical (land) Characteristics

1. What is your main occupation?
   1. Farming 2. Daily laborer
   3. Government employee 4. Other specify

2. If your main occupation is farming, how many plots of land do you have?
   1. 1___ 2. 2___ 3. 3___ 4. 4__ 5. 5 and above___

3. What is the size of landholding of the household in ha?
   1. <0.25
   2. 0.26-0.50
   3. 0.6-1.0
   4. 1.1-1.5
   5. 1.6-2.0
   6. >2.0

4. From this landholding size, for what purpose do you use in Hectare?

    1. Cultivated land________
    2. Grazing land________
    3. Fallow land____________
    4. Home stead area_________
    5. Others _________

5. How do you see your current land holding to support the household?

    1. Insufficient   2. Sufficient   3. Excess

6. If your answer is insufficient, do you have any option of having additional land?

    1. Yes   2. No

7. If your answer is yes what are the options? ____________________

8. How do you describe the slope of your cultivation land?

    1. Flat
    2. Gently sloping
    3. Moderately sloping
    4. Steeply sloping

9. What is soil color of your cultivation field?

    1. Gray   2. Reddish
    3. Brown   4. Black   5. Other color, specify

10. How do you describe the fertility of your plot of land?

    1. Highly fertile
    2. Medium
    3. Low

11. Type of the soil

    1. Sandy
    2. Clay
    3. Loam
    4. Sandy clay
    5. Other (specify)

12. What is the distance of your cultivation field from your residence?

    1. Less than five minutes walk
    2. Five to ten minutes walk
    3. Ten to fifteen minutes walk
    4. Fifteen to twenty five minutes' walk
    5. Twenty five to thirty five minutes' walk
    6. Over thirty five minutes' walk

13. How do you perceive the distance of your cultivation land from your residence?

    1. Near
    2. Far
    3. Very far

Part II- Soil and water conservation activities

1. Type of improved SWC practices applied in your area
   1. Stone bund 2. Soil bund
   3. Fanya-juu 4. Other (Specify)
2. Area or length covered by each you practiced on timad in meter/ha
   1. Stone bund_________ 2. Soil bund_________
   3. Fanya-juu_________ 4. Other (Specify)______
3. Who construct the structure?
   1. Government 2. World food program
   3. Community 4. Household 5. Others (Specify)
4. Who maintained the structure?
   1. Government 2. World food programme
   3. Community 4. Household 5. Others (Specify)
5. Has it ever been dismantled for the last three years?
   1. Yes
   2. No
6. If the answer for question No.5 is yes who dismantled/destructed it?

----

7. Would you tell us why it was dismantled? --
8. Have you practiced any traditional soil conservation practice for the last three years?
   1. Yes
   2. No
9. If yes, please would you tell us its name and the area or length covered by it?

Name ----------------------------------area/length-----------------------------------timad/km

Name -------------------------------- area/length------------------------------------timad/km

10. Which type of conservation structures you prefer?
    1. Improved type
    2. Traditional type
11. Please would you tell us the advantage and disadvantage of each?

A) Advantage for improved type

Stone bund ---

Soil bund ---

Fanya-juu ---

Others ---

B) Disadvantage for improved type

Stone bund ---

Soil bund ---

Fanyajuu --

Others ---

C) Advantage for traditional type --

d) Disadvantage for traditional type ---

12. In which land use, do you use more SWC practices on your land nowadays?

1. Cultivated land 2. Grazing land 3. Closure areas

13. To what extent have the SWC activities carried on so far has decreased the degree of land degradation and plant/forest depletion?

1. Highly decreased 2. Decreased 3. No change 4. Rather increased

14. Do SWC activities carried out so far brought about a significant improvement in your livelihood?

1. Yes 2. Fairly 3. No 4. Rather worsened

15. Are you willing and committed to continue with the conservation, protection, maintenance and expansion of the SWC activities on your own if incentives and other assistance are discontinued?

1. Yes 2. No

16. Do you face labor shortage during SWC activities in public campaign? 1. Yes 2. No

17. If your answer is yes, how do you overcome this shortage of labor?

1. ___________
2. ___________
3. ___________

18. **What is your decision and response towards the newly introduced SWC technologies?**

1. Applied but removed it later 2. Applied but no maintenance

3. Applied and maintained it 4. Applied and maintaining with replicating it

19. What measure should be taken to improve the sustainability of SWC practices on your area?

____

Part III- Perception on erosion

1. Do you perceive that land degradation as a problem in your kebele in general and in your farm plots in particular?

1. Perceived
2. Not perceived 3.mis perceived

2. If yes, would you please tell us the forms of land degradation in your area?

1. Soil erosion
2. Soil nutrient depletion
3. Change in soil structure
4. Chemical contamination
5. Salinity
6. Other (specify)

3. How do describe its severity?

1. Highly 2. Medium 3. Low

4. If soil erosion is a major land degradation problem in your farm area would you tell us the main and root causes for such hazards? (Please thick as √ all the possibilities)

1. over cultivation
2. Over grazing
3. Ploughing of steep slopes
4. Deforestation
5. Water shed effect (excessive rainfall)
6. Population pressure

7. Weak soil conservation activities 8. Other (specify)

5. Do you and your family members have real perception that soil erosion as critical problem in your farm plots?

1. No, I have no perception about it
2. I have low perception about it
3. I have medium perception
4. Yes, I have strong perception

6. Is declined soil fertility a cause for the failure of crop productivity and production?

1. No, I have no perception about it
2. I have little perception about it
3. I have some perception about it
4. Yes, I have strong perception

7. Do you think that low soil fertility may be a result of loss of topsoil?

1. No, I have no idea about it
2. I have little idea about it
3. I have some perception about it
4. Yes, I have strong perception

8. Do you think that low soil fertility may be a result of reduction in fertility or reduction in important soil nutrients?

1. No, I have no idea about it
2. I have little idea about it
3. I have some perception about it
4. Yes, I have strong perception

9. Are you aware of available soil conservation techniques minimizing land degradation problems and in its effect mainly in increasing productivity and production of food grain?

1. No, I have no perception about it
2. I have little perception about it
3. I have some perception about it
4. Yes, I have strong perception

10. Have you ever thought that appropriate and timely available institutional support such as extension service, training and credit, is important in boosting agricultural production?

1. No, I have no perception about it
2. I have little perception about it
3. I have some perception about it
4. Yes, I have strong perception

11. Have you practiced any soil conservation measures?

1. Yes
2. No

12. If yes, which type of soil conservation measures you practiced?

1. Improved
2. Traditional

13. How do you perceive the effectiveness of the in conservation measures in retaining soil erosion compared to the traditional ones? 1. Less effective 2. The same as traditional ones 3. Better

14. How do you perceive the ability of the introduced conservation measures to ensure sustainable yield compared to the traditional ones?

1. Less able than the traditional ones
2. The same as the traditional ones
3. Better than the traditional ones

Part IV-Economic sustainability

1. What is the size of land allocated for different crop production and how much production do you get?

Crop type	Land allocated in Ha	Production in Quntals	
		Before SWC	After SWC
Teff			
Wheat			
Barley			
Beans			
Pea			
Maize			
Millet			
Potato			
others			

2. If there is an increment or reduction in production, what will be the reason?______________

3. How do you see the productivity of your plots of land after the implementation of SWC practices?
1. Increase 2. Constant 3. Decrease

---

4. Describe the livestock you own

Livestock type	Total number	TLU
Cows		
Oxen		
Calves		
Goat		
Sheep		
Donkey		
Horses		
Mule		
Others, specify		

5. What is the source of animal feed (rank the source of animal feed according to their importance)?

1. Communal land
2. Private grazing land
3. Crop residue
4. Hay
5. Other sources, specify _______________

6. How do you describe the trend of animal feed?

1. Declining 2. The same
3. Increasing 4. I do not know

7. What should be taken as a remedy for shortage of animal feed?

1. Distributing communal grazing land for private use
2. Increasing grazing land area
3. Introduction of controlled grazing
4. Reduction in livestock number
5. Other, specify

8. Why do you sell animals (rank them according to their importance)?

1. Purchase of agricultural input (fertilizer, seed, hire labor)
2. Purchase of oxen
3. Purchase of food crops for house consumption
4. Because of their low productivity (low milk yield)
5. Pay taxes and other social obligations
6. Repayment of debt
7. Reduce stocking
8. Good seasonal marketing (high price for animals)
9. Other, specify

9. What are the major sources of income?

1. Sales of crop production 2. Sales of animals feed
3. Off farm income 4. Income from migration 5. Other specify

10. Does any member of your family involve in off-farm activities? 1. Yes 2. No

11. If your answer is yes, fill the following table

Types of work	Income in birr per year
Labor employment	
Handcraft	
Brewery	
Remittance	
Others	

Part V-Social sustainability

1. Do you participate in SWC works in your village? 1. Yes 2. No

2. If your answer is yes, what motivated you to contribute (put according priority if more than one answers)?

1. My own willingness 2. The decision of the village community
3. The decision of government agencies 4. Others

3. How do you evaluate the extent of your participation in SWCM taking the following indicators? Fill the following table

community participation in SWC indicators	v.high	high	fair	low	v.low
Planning and designing					
Implementing					

Monitoring and evaluation					
Taking corrective action					

4. Indicate the benefit gained from SWC management using the following indicators:

Benefit indicators	Rating				
	Highly increased	Increase	To Some extent	decrease	Highly decreased
Land fertility					
Crop yield					
Fodder					
Water suply					
Soil erosion					
Restoration of grazed ln.					

5. Do you need external support or incentive to take part in SWC activities?
   1. Strongly need 2. Need
   3. Fairly need 4. Do not need
6. If you need, what type of support (put according the priority need).
   1. Finance 2. Input Supplies 3. Training 4. Food 5. Others
7. Did the assistance create self-reliance or dependency?
   1. Self-reliance 2. Dependency
8. Should the assistance be continued or discontinued?
   1. Continued 2. Discontinued

9. If your answer is the assistance should continue, why?
   1. ____________________ 2. ____________________
   3. ____________________ 4. ____________________
10. is there any local bylaw regarding to SWC? 1. Yes 2. No
11. if your answer is yes, what is the measure if you break the bylaws ____________
12. Do women of your village equally participate in SWC works? 1. Yes 2. No
13. If your answer is no, what are the reasons that limit their participation if your answer to the above question is no (according to priority)?
    1. Male know better attitude
    2. Housework load
    3. Capacity problem
14. Are women equally (fairly) represented in the leadership of the village SWC management?
    1. Yes 2. No
15. Do women equally participate in the use and control of assets of the village including land, plants, fodder and water? 1. Yes 2. No

Part VI- Institutional sustainability

1. is there any permanent development agents (extension worker) in your kebele?

   1. Yes 2. No

2. Have you got sufficient extension services?

   1. Yes 2. No

3. If yes, would you tell me the period and length of time you have been visited and got assistance?

   1. Every day
   2. Every week
   3. Twice in a month
   4. Frequently every month
   5. Sometimes (at peak period of farming)
   6. Other (specify)

4. Did you get any training concerning soil conservation techniques and direct and indirect impacts in line with crop productivity and its environmental imbalances?

   1. Yes 2. No

5. Have you access to any extension program to improve the SWC practices in your area?

   1. Yes 2. No

6. If your answer is yes, who have more contact with extension agent?

   1. Husband 2. Wife 3. Children 4. All have equal contact

7. Where do you get information about SWC measures?

   1. Traditionally 2. From DAs
   3. From neighbors 4. From NGOs 5. Others, specify

8. during the last one -year, have you ever taken a loan in cash or kind?

   1. Yes 2. No

9. Where do you get credit when you face shortage of money? (Put in order of significance by giving 1 to the most important)

   1. Ikubs 2. Local money lender
   3. Micro finance institutions 4. Others, specify

10. Reason for obtaining loan

    1. To buy farm or other implements
    2. To buy inputs (Fertilizer, seed...)
    3. To buy food grain for Consumption
    4. To buy non- food items (clothing, service
    5. To buy livestock and oxen
    6. Other (specify) 7. To renting labor for SWC practices

11. Source of the land (Ownership)

    1. Private
    2. Leased/Rented
    3. Shared 4. Totally public 5. Other (Specify)

12. Which type of ownership do you think makes a farmer to be more committed to make short-term and long-term investment so as to develop his/her farmland?

    1. Public 2. Private

13. List any institution and policy related factors that you think as obstacle to the SWC practices?____________