



**FARMERS' PERCEPTION AND ADOPTION OF PHYSICAL SOIL AND
WATER CONSERVATION PRACTICES AT FARM LEVEL THE CASE
OF GORCHE WOREDA SIDAMA REGIONAL STATE ETHIOPIA**

MSC. THESIS

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WATER CONSERVATION PRACTICES AT FARM LEVEL: THE CASE
OF GORCHE WOREDA SIDAMA REGIONAL STATE OF ETHIOPIA.**

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First, I declared that this thesis own work. I have followed all ethical and technical principles of data collection, data analysis and completion of this thesis. This thesis is submitted in partial fulfillment of the requirements for M.Sc. Degree at the Hawassa University. The thesis is deposited in the Hawassa University library and is made available to borrower under rules of the library. I seriously declare that, this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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DEDICATION

I dedicated this thesis manuscript to my beloved parents and friends for helping me with affections and love and for their dedicated partnership in the success of my life.

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ABBREVIATIONS AND ACRONYM

CSA	Central Statistical Authority
DA	Development Agent
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FFW	Food for Work
FGD	Focus Group Discussion
GDP	Growth Domestic Products
IJEMA	International Journal of Environmental Monitoring and Analysis
MoARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
GWANRDO	Gorche Woreda Agricultural and Natural Resource Development Office
NGO	Non-Government Organization
NRC	National Research Council
SNNPRS	South Nations Nationalities and People Regional State
SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa
ISWC	Improved Soil and Water Conservation
TLU	Tropical Livestock Unit
UNCCD	United Nations Convention to Combat Desertification

USAID	United States Agency for International Development
WOCAT	World Overview on Conservation Approaches and Technology

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ABSTRACT

The general objective of this study was to assess farmer's perception and adoption of improved soil and water conservation practices at farm level in Gorche Woreda, Sidama Regional state of Ethiopia. The study used cross-sectional designs with qualitative and quantitative data type to answer research questions of the study. This study also used multi-stage sampling procedures. Both primary and secondary data was collected and used. The primary data was collected from, household level survey; focus group discussion and key informants' interview. For this study 139 household heads were selected from two kebeles which have different agro-climatic zone. Descriptive statistics was used to describe the nature of data by indicating the significance of the relationship between dependent variable and independent variables. Binary logit model was used to identify factors affecting farmers' adoption of improved soil and water conservation technologies in the study area. Improved soil and water conservation practices that farmers practiced in the study area includes: soil bund, hillside terraces, cut-off drain and rain water harvesting. In the study area education status, extension services and slope of land were found positively and significantly affect adoption of improved soil and water conservation practices while farmland distance from homestead and off-farm income were negatively and significantly related with adoption of improved soil and water conservation practices by farmers. From the result of the study, education (0.050), extension service (0.025), farm land distance (0.000), slope of land (0.008), off-farm income (0.002) and perception (0.022) were the major factors that influenced farmers' adoption of improved soil and water conservation practices. Thus to effectively address issues of adoption of soil and water conservation practices, it is to recommend that, the study area agriculture and rural development office, non-governmental organizations and other concerned bodies should take in to consideration the factors that discourage farmers' adoption of physical SWC measures.

Key words: Farmers' perception, Adoption, SWC, Binary logit model

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Soil and water are the most important resources for the existence of human beings and biomass on the earth's surface. The whole creations on the earth's surfaces are depending on soil and water. Therefore, these resources need sustainable use and management to enhance food security. The land resources such as soil, water and forest are under serious degradation due to continuous unwise use of those resources by human beings (Kibemo, 2011).

A serious environmental problem for continuous agricultural output in today's world is soil degradation. In the last 50 years, 1/3rd of the world agricultural land has been lost by erosion at a rate of more than 10 million hectares per annum (Pimentel, 2006). According to Holden and Awdenegest 2007, soil erosion minimizes agricultural output by reducing organic content, nutrients and water retention capacity of soils. Eight percent of the world land to degrade and 15% of the production is reduced because of soil erosion. In each year, it removes 75 billion metric tons of soil from agricultural land by water and wind erosion (Hurni, 2009).

The major factors for soil degradation in most developing countries are improper and unsustainable use and management of land. Africa is one of the continents highly affected by soil erosion. It affects about 5-6 million hectare of land in each year (Mulugeta, 2010). Continuous cropping for long period of time, rapid population growth, cultivation of steeply and marginal lands, poor soil conservation practices and over grazing are the major causes of soil erosion in Africa (Abera, 2003).

In Ethiopia, soil erosion is a major problem facing farmers that limit their quality to increase agricultural productivity and production (Menale *et al.*, 2008). Therefore, soil erosion is the major cause for Ethiopian low agricultural production, food insecurity and rural poverty. Soil erosion is the result of human, physical and socio-economic factors such as continuous cultivation with little improvement of SWC practices, wide spread use of manure and crop residues for household consumption (Woldeamlak & Sterk, 2002; Aklilu, 2006).

According to (Kruger *et al.*, 1996) 50% of the high land areas of Ethiopia had affected by erosion. Twenty percent were highly washed away and 4% is seriously eroded beyond recovery. Erosion rate estimated at 130 tons/hectare/year for crop land and 35 tons/hectare/ year for all land in the high lands (Barry, 2003). Ethiopia losses nearly 2 billion tone of fertile soil per annum (Berhanu *et al.*, 2009).

As a result, soil and water conservation practice is a key factor for sustainable growth of agricultural sector since the country's economy is highly depends on agriculture. The country has taken different conservation methods to alleviate the problem of soil erosion (Mulugeta *et al.*, 2010).

In Ethiopia various efforts made to install conservation measures on erodible lands were initiated following the 1975 land reform and establishment of peasants' associations, which were instrumental in mobilizing labor and assignment of local responsibilities. This was further expanded with the involvement of the world food program, which had been providing food- for work incentives for conservation activities in the 1980s and early 1990s (Bekele and Holden, 1998). Even if considerable areas of erodible land have been treated, maintenance of the structures has become a cause for concern to the implementing agencies (Tato, 1990). In the FFW program benefits, conservation measures on farmlands like construction of soil and stone

bunds, terracing, fanaya juu, tree planting and cut-off drain on agricultural areas have been introduced.

In spite of this huge effort that have been demonstrated, farmers construct soil erosion controlling structures with incentives of FFW and destroyed the structures in the absence of incentives. They considered the conservation methods were affects their grazing land and use much space (Bekele& Holden, 1998). Currently, farmers considered the conservation mechanisms as a common activity on farm land but still there are limitations. Therefore, Farmers' perception of soil erosion plays a key role in their decision making on land use and management practices. Different farmers may have different attitudes towards soil conservation. Farmers' perception affects the selection and continued use of soil conservation practices (Bandara,2008). Sometimes farmers who have good attitudes also may not practice soil conservation at a good level due to other factors influencing their practices. However, agricultural planners and scientists forget that farmers, best understand their own lands and objectives (Taangahar et al, 2011). While national policy and top down agricultural development strategies have their place, these may only be implemented through the active participation of farmers. It is the farmers who mobilize their resources and take risks, to assist their crops overcome soil constraints on productivity. Many farmers are aware of land degradation, but their priorities are food production and income generation during the current or next cropping cycle, rather than in the more distant future (Taangahar et al, 2011).

Perception of soil degradation factors and how to prevent them is a necessary condition for farmers' to investment in conservation technologies. Insufficient attention has been given to examining local-level factors, like socioeconomic, institutional, and biophysical, affecting perception of farmers about their participation in SWC activities (Stahl, 1990; Million, 1996; and

Azene, 1997). According to Amarasekara et al. (2009), and Ulimwengu and Sanyal (2011), willingness to invest in soil conservation measures increases with farm income, level of awareness and ownership security of land. Thus, appropriate understanding of these factors would assist in the formulation and implementation of the policy interventions designed to induce voluntary continued use of SWC measures.

The sustainability of the future depends on our present actions to combat soil degradation and to introduce sustainable use of resources; there is a need to take action participant the local people in design and preparation of conservation measures. Farmers have a worth of knowledge about their problems, needs, environment that can be useful for planners. Moreover, farmers showed greater readiness to accept, and participate in development programs that directly address their needs (Zemenfes, 1995).

Sidama region is one of tenth Region of Ethiopia. A large part of the region's land is exposed to soil erosion. As a result, the soil becomes unable to satisfy the rapidly growing demands of the population. Gorche district of Sidama regions, as most of the farmers are reluctant to adopt the physical soil and water conservation practices; the soil has been continuously exploited and degraded. As a result, majority of rural inhabitants are suffering from food insecurity (GWARDO, 2021). This is mainly because the soil is incapable to support cultivation due to soil erosion and its related problem (Mekuria, 2005). Taking these impacts in to account, Ethiopian government and NGOs have made several interventions in the form of soil and water conservation practices. Of the various interventions, extensive physical soil and water conservation projects have been carried out under the support of the World Food Program in the form of productive safety net program (Shiferaw, 2008). Regardless of the heavy capital and human resources investments, the natural resource base is deteriorating from time to time and

becomes major causes for food insecurity and vulnerability (Fekadu *et al.*, 2013). As a result, the situation remains unchanged and subsistence agriculture has extended into marginal lands leading to damaging and threatening the long-term viability of the environment and agricultural production (Kirubel *et al.*, 2011).

Therefore, there is a need to give focus to assess current adoption status of physical SWC practices, farmers' perception and adoption of physical SWC practices and factors affecting farmers' perception on adoption of these practices in order to address constraints that inhibit adoption and continued use of measures through appropriate land policies and investment programs. Thus, this study was aimed to assess farmers' perception and adoption of physical soil and water conservation practices.

1.2. Statement of the Problem

Natural resource depletion has been a major problem for environmental, socio-economic, policy, and soil-water conservation practices in Ethiopia. Nowadays, soil degradation is significantly reducing yield and it is more acute in developing countries than developed countries. For instance, Ethiopia losses at about 940million tons, or averages of 18tons per hectare (Hurni, 2015). As a consequence of soil erosion, it is estimated that more than 30,000 hectare of the country's cropland was out of production annually (Erkossa *et al.*, 2015).

Most soil and water conservation practices in Ethiopia are physical SWC practices. Farmers consider that the income from physical conservation measures was negative in general at least in the short term (FAO, 2010). In spite of the efforts made over the last two decades in the agricultural sector, a combination of population growth, little intensity of soil and water conservation practices, and climate disruption has resulted in a dramatic fall in per capita food production (Wegayehu, 2006). This has resulted in a vicious circle of increasing soil erosion, low agricultural productivity, and reduced capacity of farm households to manage soil and water resources (Bewket, 2009). Accordingly, since mid of 1990s, both government and development agencies have been strongly engaged in introducing physical soil and water conservation practices (Eleni, 2008).

Despite the fact that massive mobilization of resources for physical SWC practices was carried out, the attention given to farmers' perception on adoption of physical SWC practices was limited. And failure to understand the factors affecting farmers' perception on adoption of these practices have contributed to the poor success of the efforts made in study area. As a result, the adoption and sustained use of such practices is below the expectation (Fikru, 2009). Therefore, the introduction and implementation of physical soil and water conservation technologies need to

consider the socio-economic, physical, institutional and agro-ecological factors affecting farmers' perception to adopt these practices.

Farmers' readiness to adopt physical SWC practices is mainly determined by their knowledge of the problem of soil erosion. Nevertheless, due to the top-down approach (have not participation of development agents with local farmers), adoption of these physical SWC practices by the farmers appears less likely (Mitiku *et al.*, 2006).

These all resulted in negative perception towards physical soil and water conservation structures. Soil erosion is one of the most critical threats to the sustainability of agricultural systems in Sidama region (Selamawit., 2016). Gorche is one of the most severely eroded districts in the Region. Although the considerable efforts were made to develop and promote different types of physical SWC practices acceptance, adoption and sustained use by the land users at farm level has not been widespread (Selamawit ., 2016). Consequently, the situation tends to be the productive top soil has been degraded causing chronic food shortages and persistent poverty. Therefore, this research aims to assess current adoption status of physical SWC practices, assess farmers' perception towards physical soil and water conservation practices at farm level and to identify factors that affect farmers' adoption of physical soil and water conservation practices in the study area at Gorche woreda.

1.3. Objectives of the Study

1.3.1 General objective

The overall objective of the study was to assess farmers' perception and adoption of physical soil and water conservation practices at farm level in Gorche Woreda Sidama regional state of Ethiopia.

1.3.2 Specific objectives

- 1) To assess current adoption status of physical SWC practices
- 2) To assess farmers' perception towards improved soil and water conservation practices at farm level and
- 3) To identify factors that affect farmers' perception on adoption of physical soil and water conservation practices at farm level in the study area.

1.4. Research Questions

The main research questions set to address the specific objectives that were mentioned above were:

- 1) What are the current adoption statuses of physical SWC practices?
- 2) How farmers perceive physical soil and water conservation practices at farm level and
- 3) What are the factors that affect farmers' perception on adoptions of physical soil and water conservation practices at farm level in the study area?

1.5. Significance of the study

Since no such study was conducted in this area, the result can provide location specific information and knowledge related to physical SWC practices, indicate the factors that need urgent intervention, and identify aspects that need further research works. It can be an opportunity to the region in general and the Woreda in particular to have an organized document that can serve as a guideline in the future development. In addition, it can indicate directions and supply information for further research, extension and development efforts for non-governmental organizations whose main concern is physical soil and water conservation and sustainable development in general. The investigation of factors influencing farmers' perception and adoption of physical SWC activities is essential to take measures that can alleviate the

constraints affecting adoption. Identification of factors that accelerate the adoption of technology can enhance the formulation of the technology and use of them. Researchers and extension workers can utilize the results of this study in modifying research and extension activities particularly for improved SWC technologies. Moreover, policy makers can benefit from this study since they require micro level information to formulate suitable agro-ecologic based policies. This was also support government and nongovernmental actors working on the issue.

1.6. Scope and limitation of the Study

Scope: This study was carried out in Sidama region Gorche Woreda at sampled rural kebele administration. Due to limited budget and time, the study covers the adoption of physical soil and water conservation practices only in one Woreda at two kebeles.

Limitation: This research was conducted Gorche Woreda and it includes only two kebele from 27 kebele of the woreda this is due to the scarcity of the resource. Although large sample size was required to deal with the subject matter exhaustively, due to limitation of resources the sample size was restricted to 139 households. Topography of the study area is very difficult for transportation and data collectors have used their foot to collect data from different parts of the study area. This consumed much of the time allocated for the research worker.

1.7. Organization of the Thesis

This thesis is organized in five chapters. The first chapter is the introduction part where the problem of the study is justified; the objectives and research questions are indicated. In the second part, theoretical and empirical literatures are reviewed while the third chapter presents materials and methods. Results and discussion, both descriptive and econometric models are

presented and discussed in the fourth chapter. In its last part conclusion and recommendations are presented under chapter five.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Theoretical Review

2.1.1 Definitions and concepts of physical SWC practices

Adoption of SWC activities: - literally the dictionary meaning is to take over something and have or use it as one's own. In context of conservation, adoption could be the people's awareness of the consequences of soil and water abuse and taking appropriate action by using available technology to avert the possible consequences of degradation and we can differentiate two kinds of adoption, the first could be spontaneous adoption, which refers to the voluntary adoption of technologies without external support or assistance other than technical guidance. And the second is acceptance with incentive.

Conservation: - A broader and a more dynamic definition sees conservation as covering "improvement" as well, developing natural resources rationally and thus enabling maximum benefit to be obtained while production capacity is preserved indefinitely (FAO,1986).

Soil conservation: - is defined in different ways by different scholars. For example, SUSTAINET EA (2010) soil conservation is the prevention and reduction of the amount of soil lost through erosion. According to Tolera (2011) defined soil conservation as the combination of appropriate

land use and management practices that promote the productive and sustainable use of soils, thereby minimizing erosion other forms of land degradation.

Water conservation: - is a way of tapping as much water as possible and storing it in tanks or reservoirs. Soil and water conservation are those activities at the local level which maintain or enhance the productive capacity of the land including soil, water and vegetation in areas prone to degradation through prevention or reduction of soil (WOCAT, 2007).

Soil erosion: -is the wearing away of the land surface by physical forces such as rainfall, flowing water, wind, gravity and anthropogenic agents (Catherine, *et al.*, 2009). It is also more specific than both land and soil degradation. It refers only to the absolute loss of top soil and nutrients. Soil erosion is a natural process in mountainous areas, but is often made much worse by poor management practices.

Soil degradation: - is defined as a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries. Degraded soils have a health status such, that they do not provide the normal goods and services of the particular soil in its ecosystem. Soil degradation is process that leads to a deterioration of soil properties and functions, often accelerated by human activities (Jones, *et al.*, 2013).

Land degradation: - is as the loss of land productivity through one or more processes, such as reduced soil biological diversity and activity, the loss of soil structure, soil removal due to wind and water erosion, acidification, water-logging, soil nutrient mining, and pollution (World Bank, 2006; UNCCD, 2014). Land degradation differs from soil degradation in that the process affects multiple component of an ecosystem and is usually discernible and must be addressed at multiple spatial scales.

Physical soil and water conservation: - refers to the various methods and measure used to regenerate or rehabilitate, preserve, and sustainable use of the soil and water resources to enhance sustainable community livelihood and environmental protection (Solomone, 2016).

Indigenous soil and water conservation is defined to be a practice or idea generated locally or imported from outside and transformed by the local people and interpreted in their way of life. Whereas Kruger *et al.*, (1996) understood traditional conservation measures as farming practices that have evolved through the course of time without any known outside institutional interventions and which have some soil conservation effects.

In Gorche Woreda there are soil conservation practices which are implemented today in different part of the Woreda which includes hillside terraces, soil bund, trench and water ways, cut off drains, rain water harvesting are the major soil conservation methods.

2.2. Adoption of physical soil and water conservation practices

Technology plays an important role in economic development in a given nation. Various authors define technology in different ways. Technology is the means and methods of producing goods and services, including methods of organization as well as physical techniques. A Lavisson (2013) point out technology is the knowledge/ information that permits some tasks to be accomplished more easily, some service to be rendered or the manufacture of a product. On other hand adoption is also defined in different ways by various authors. Loevinsohn *et al.*,2012 defines adoption as the integration of a new technology in to existing practice and is usually proceeded by a period of ‘trying’ and some degree of adaptation.

According to De Graaff et al 2008 categorized adoption in three phases in the adoption process: the acceptance phase, the actual phase and the continued use phase. The acceptance phase

generally includes the awareness, evaluation and the trial stages and eventually leads to starting investing in certain measures. The actual adoption phase is the stage whereby efforts or investments are made to implement soil and water conservation measures on more than trial basis. The third phase of final adoption is the stage in which the existing soil and water conservation measures are maintained over many years and new ones are replicated on other fields.

Adoption of any innovation is not a one step process as it takes time for adopt. The level of adoption of technology varies among regions and attributes of the technology itself. Therefore, adequate understanding of the process of technology adoption is necessary for designing effective agricultural research and extension program. According to Hailu, 2011 the adoption of an innovation by an individual requires the satisfaction of at least three conditions. These are the availability of sufficient information, the existence of a favorable attitude towards the innovation, and the physical availability of the innovation. Therefore, adoption is often a continuous process, and may occur in a gradual or step wise manner, sometimes ending in only partial adoption. In this context, adoption of soil and water conservation means that the degree of level acceptance and use of different soil and water conservation practices partially or fully by household farmers. Kessler (2006) considers that soil conservation measures are totally adopted only when their implementation is sustained and fully integrated in the household farming system. A farmer is considered an adopter if he/she implement one or more of the introduced soil conservation measures.

2.3. Methods of physical soil and water conservation practices

There are no universal conservation practices that work everywhere. Planning soil and conservation is likely having a large array of techniques and practices set out each in separate.

The objective of planning soil and water conservation is to make up a system by selecting a set of individual items which are each relevant to the condition, and which can be combined into a workable system (FAO, 1986). In Ethiopia, traditional soil and water conservation has been common since historical times (Hans-Joachim *et al.*, 1996). Yet due to inefficiency of traditional methods, it was only after the famine of the 1970s that many of the activities of soil and water conservation and resource degradation have been recognized to be a serious problem in highland Ethiopia. Adopted conservation methods were diversion channels, terraces, stone bunds and earth dams, which are mainly practiced in highland Ethiopia. Initially, most of the soil conservation works included construction of stone and earth embankments, which farmers did not appreciate (Habtamu *et al.*, 2006).

2.4. Farmers' perception on physical soil and water conservation

Several of the soil and water conservation campaigns in many parts of the world did not succeed due to low adoption of proposed technologies (Kebede *et al.*, 1993). One of the factors is poor perception of farmers of the problem itself (Robert, 2012). Farmers' perception of land degradation plays a key role in their decision making on land use and management. Farmers may be aware of the degradation of their land, but they may not be aware of the causes and consequences. Some farmers may not recognize the problem at all or others may not care for various reasons (Graaff, 1993). For instance, low level of education and ignorance were causes of low level of awareness on soil erosion processes and major impediments to the implementation of soil conservation measures (Terefe, 2017).

Farmers' perception of soil erosion and soil fertility problems and adoption of technologies are considered a two-stage decision process (Gould *et al.*, 1989). Recognition of the problem is a first stage before adoption, because farmers take land management decisions based on their

understanding and awareness of the problem. In their study of adoption of soil conservation technologies by small holder farmers in the Philippines (Cramb *et al.*, 1999) conclude that perception of soil erosion was the key factor that determined the adoption of the provided technologies, whereas farmers who were affected by and aware of soil erosion were more likely to take proposed erosion control measures than those who were not aware of the problem.

The farmers' perception of the problems of soil erosion and soil fertility is determined by a number of socio-economic and biophysical factors. These factors include access to information, education, and erosion severity, and experience, resource endowment, farming practices, productivity, farm characteristics and household attributes (Cramb *et al.*, 1999). For instance, due to the gradual nature of soil degradation, the decline in productivity is usually masked by annual yield fluctuations as a result of climatic and other factors. This affects the farmers' perception of soil degradation (Terefe, 2017). (Shiferaw and Holden, 1998) concluded that under the current conditions in the Ethiopian central highlands, soil and water conservation interventions should consider farmers' conservation knowledge and practices to improve the possibility of acceptance and adoption of the recommendations. Farmers rather frequently reject newly introduced SWC technologies even when they are aware that the measure protect and improves productivity of their lands. Although an understanding of the physical erosion phenomena is important for the formulation of erosion control strategies, it is also vital to understand social relations influencing management choices. Unsustainable farming practice is linked to a lack of choice due to poverty rather than linked to neglect. Subsistence level farmers do not have the economic or labor capacity to implement necessary conservation measures. Some cases farmers are aware that some of their actions are actually damaging the land, but the immediate benefits of these actions seem more important than long-term degradation.

In the South Region, different types of soil and water conservation measures (both biological and physical) are practiced; however, site suitability- of measures has not been assessed. Knowledge of farmers' perceptions and attitudes toward land degradation is an important first step to tackling the problem. Land degradation is not a new phenomenon in the region. It is often claimed that farmers do not fully understand the causes and consequences of land degradation. Nevertheless, farmers frequently undertake traditional methods of soil and water conservation such as simple diversion ditches across their fields to divert runoff and therefore prevent their land from becoming waterlogged (Lakew *et al.*, 2006)

2.4.1. Soil erosion in agricultural system

Soil erosion in agricultural system is a very important problem to manage. The productive layer of dirt is called the humus or top soil. If this layer is eroded away, then the ground is very unproductive in producing crops. Soil can be eroded away by wind and water. High winds can blow away loose soils from flat or hilly terrain. Water erosion generally occurs only on slope. There are a number of different methods of reducing soil erosion. Contour tillage reduces water erosion on hilly areas plowing is done across the hill rather than straight up and down. One problem with this is that some fields' shapes make this method impractical. The terraces can also be constructed so to reduce water erosion.

One method designed to reduce to wind erosion is the establishment of windbreaks. Windbreaks work well in reducing wind velocities over fields, but they have one serious drawback to farmers. That is, it takes out crop land and shade out crops to the side of them as well (Taffa, 2002).

2.4.2. Land degradation in East Africa

Land degradation has been a major global agenda because of its adverse impact on environment and food security and the quality of life. Soil erosion threatens agrarian societies with a loss in productivity and by undermining long-term land management strategies and livelihoods. Agricultural activities that make the land surface more susceptible to soil erosion. Soil erosion account for 28% (2 billion hectares), overgrazing for 34% and deforestation for 29% of soil degradation Worldwide (Tekalegni, 2011).

According to UNCCD, (2013) and Jones *et al.*, (2013) report in Africa land degradation affects up to two thirds of productive land area. Over Africa's total land area (2,966 million hectares), 494 million hectares is degraded. Seventeen of the 54 Africa's countries are classified as least developed countries with the majority of their agricultural lands found in semi-arid region. Thus, these countries are more susceptible to land degradation and desertification, given the fragility of dry land soils. In dry land Africa, people already suffer from poverty, food insecurity, and high mortality rates, among other hardships, and these are exacerbated by land degradation, and often leading to further impoverishment, migration, and conflicts.

Eighty percent of the chronically hungry are smallholder farmers in Africa according to (Bunch, 2011). Their hunger and poverty are related to low crop yields, land degradation, loss of soil fertility, and periodic drought. As land and water resources are degraded, critically important ecosystem services such as the regulation of water flows and flooding, soil formation, and nutrient water cycling are negatively impacted or lost (Noble, 2012). The loss of these ecosystem services is undermining agricultural production and as crop land productivity stagnates or declines the pressure to clear and covert new lands for crop and livestock production increases.

Land degradation and its challenges related to soil fertility and agricultural production are particularly acute in Sub-Saharan Africa, where yield gains are greatly needed. More than 95 million hectares or 75 percent of the arable land in Sub-Saharan Africa have degraded or highly degraded soil, and are so depleted of nutrients that major investments are needed to restore their productivity (NRC, 2007). The other big issues that reported are lack of consensus on the magnitude and severity of land degradation plus its effects in Sub-Saharan Africa (SSA) and Eastern Africa region in all together (Nkonya *et al.*, 2013).

The principal environmental problem in Eastern Africa highlands are land degradation, manifested mainly in the form of soil erosion, gully formation, soil fertility loss, water scarcity, and reduction in crop yield. However, in Eastern Africa the resource loss due to land degradation is believed to be huge (Kirui and Mirzabaev, 2014). Generally, a number of different pressures can signify land degradation and soil erosion in continent; these are unsustainable land use including deforestation, overgrazing, over cultivation, poor irrigation practices, and polluting industrial activities (UNCCD, 2009).

2.4.3. Land degradation in Ethiopia

From sub-Saharan Africa countries, Ethiopia is particularly threatened by land degradation processes due high dependence of agriculture, population growth, frequent famine and poverty. Ethiopia is one of the poor countries in sub-Saharan Africa most seriously affected by land degradation which has been more pronounced (Yihewew and Tilahun, 2014). In Ethiopia soil erosion is the leading cause of land degradation, contributing to loss of crop production, a decrease in biodiversity, food and livelihood insecurity, siltation of water ways, shortage of fodder, and reduction of livestock productivity (USAID, 2009; Yisehak *et al.*, 2013). Similarly, land degradation is a major cause of the country's low and declining agricultural productivity

(FDRE, 2015) and this leading to food insecurity and rural poverty in the country and associated adverse economic and social consequences.

The situation is much more severe in the highland areas where 85% of the human and 77% of the livestock population are living and agriculture is intensive (Mazengia.,2010). In Ethiopia more than 2 million hectares of the highlands have been degraded beyond rehabilitation and additional 14 million hectares severely degraded, which is reflected in cereal yield reduction averaging less than 1.2 tones per hectares in most of the highlands (IJEMA, 2013). According to Lakew, *et al.*, (2005) the major causes of degradation in Ethiopia are rapid population increase, deforestation, low vegetative cover, unbalanced crop and livestock production and negative coping strategies such as burning of animal dung and extensive use of charcoal. Similarly, weak land use management and lack appropriate soil conservation measure have played a major role for causing land degradation problems in the country.

Topography, soil types and agro-ecological parameters are also additional factors playing significant role the degradation processes influenced by human being; land tenure insecurity which is related to policy failures of past government and implicated in the growing land degradation problem in Ethiopia (FDRE,2015). As result of this severe land degradation, which in turn caused by different factors; soil productivity has been negatively affected and agricultural production has not been meeting the basic food requirements of the growing population.

2.4.5. Causes of land degradation

Land degradation is caused by natural and anthropogenic or human induced factors. The natural factors that causing land degradation is high intensity of rain fall and steep relief are the major ones. Whereas human induced factors such as land use or land cover change, overgrazing, over

cultivations, farming of fragile steep slopes; and inappropriate soil management practices or cropping system which include continuous cropping together with removal of crop residues, low external inputs and absence of adequate soil nutrient saving and recycling technologies (Adugnaw, 2014). To sum up, natural resource degradation in general and land degradation particularly caused by agricultural mismanagement, deforestation, poverty and population pressure and unmanageable livestock production system are the major ones.

2.4.6. Mismanagement in agricultural resource management

Soil erosion and water runoff are natural events, clearly observed on unleveled ground and areas where vegetation is scarce or absent. However, erosion and water loss threaten the livelihoods of hillside farmers throughout Ethiopia. Fortunately, the rate at which erosion and water loss occur can be reduced significantly with appropriately applied soil and water conservation technologies (Wolka, 2014).

There are certain agricultural practices that are environmentally unsustainable and at the same time, they are the single biggest contributor to the world wide increase in soil quality decline. The tillage on agricultural lands is one of the main factors since it breaks up soil in to finer particles, which increase erosion rates. The soil quality decline is exuberated more and more as a result of the inappropriate land use particle which include insufficient or excessive use of fertilizers shortening the fallow period in shifting cultivation, poor irrigation practices and lack of anti-erosion measures when the soil is fragile, among others (Jones, *et al.*, 2013).

2.4.7. Deforestation

Deforestation and forest degradation are another major environmental issue in Ethiopia, with most of the country's forest already lost and the remaining areas of closed forest being depleted

at a rapid pace, despite a growing awareness of their importance for livelihoods, agro-forestry, ecosystem services and ecological resilience. The pattern of deforestation has been uneven; with some regions particularly the Ethiopia highlands being almost completely deforested (Eshetu, 2014).

Deforestation is closely connected to the issue of soil erosion and land degradation, but is an important environmental issue in its own right because it leads to the loss of important forest resources on which livelihoods may depend, and it causes other environmental issues in turn, particularly biodiversity loss and soil erosion. The use of wood and other biomass for fuel and the expansion of agriculture in to forested areas fostered a high rate of deforestation and ultimately stripped the land of vegetative biomass exposing it to high levels of soil erosion. Even this remaining forest is being depleted at rapid rate, partly because nearly 95% of nation's energy consumption is from biomass fuels (MoARD, 2007).

2.4.8. Livestock population pressure

Livestock are an irreplaceable source of livelihood for the poor and are one of the fastest growing agricultural sectors globally (World Bank, 2008). In SSA the production of livestock increased by 3% between 2000 and 2010. Therefore, this change was driven by increasing livestock numbers rather than gains in livestock productivity (Upton, 2012) putting pressure on sub-Saharan Africa grazing lands and traditional grazing systems.

Ethiopia also has the largest livestock population in Africa, which exerts additional pressure on the renewable natural resources. According to MoFED (2006), resource mismanagement coupled with their underutilization has so far reduced their contribution to Ethiopian's overall development. Overgrazing and the expansion of farming in to unsuitable land, caused by

increasing livestock population without increasing economic productivity is leaving the land bare. As a result, large areas of the country, particularly on the northern and central highlands, have been exposed to loss of fertility, soil degradation and ecological imbalances due to poor livestock management, mainly based on the free grazing system.

The scarcity of grazing land and livestock feed has forced the widespread use of crop residue to feed livestock. When crop residues are removed for livestock feed, soil losses organic matter and nutrients. This breach in the soil nutrient cycle seriously depletes soil quality, increases erosion, and eventually reduces soil productivity (MoARD, 2007).

2.5. Factors influencing the adoption physical SWC practices

Lynne *et al.*, (1988) on their study on attitude and farmers' conservation behavior stated that factors such as income and nature of terrain affect conservation behavior. Farmers' attitude influences the amount of effort exerted in conservation. The author also suggested other factors including attitude towards investment risk, extension, education and percentage of cultivated land affect conservation decision. A study conducted by Wogayehu (2003) on soil and water conservation decision behavior using multinomial logic analysis showed that, plot area and slope, access to information, and project assistance have positive and significance influence on conservation decision.

The problem of sustainability concerning to soil and water conservation practices with the system of agriculture is the issue of many countries, particularly for developing countries whose economy largely depend on agriculture (Menale *et al.*, 2008; Fikru, 2009). In response to the high demand of improving the productivity of farmland many countries including Ethiopia are engaging massive soil and water conservation works despite the fact that the adoption of soil and water conservation measure are not satisfactory.

2.5.1. Demographic Factors:-

Age of the household head: Age is another issue found to be important factor in the adoption of soil conservation technology. Chombar (2004) found that age of the household head has a positive and significant relation with cut-off drain type of SWC adoption. Fikru (2009) found similar results in koga watershed. On the contrary, Eleni (2008) indicated that the age of the household head has negative, but not significant influence on the continued use of SWC technologies in southern Ethiopia. Another study conducted by Sidba in 2005 he concluded that younger household head have used the new soil and water conservation measures. Featherstone and Goodwin (1993) reported that an older individual who is looking at a shorter time horizon might not be able to recoup all of the benefits from conservation investment

Education of the household head: 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; Habtamu, 2006). Because of who Lack of knowledge to adopt conservation measurements. The findings of Krishana *et al.*, 2008 and Fikru (2009) indicated the fact that better education level of the household heads has strong positive relation with their adoption behavior because of their ability to find new information and understand the new technologies. In the contrary the findings of Eleni (2008) showed that there is no significance correlation between education level and adoption of SWC measures. According to Eleni the reason for this negative, but not statistically significant result was the positive and significant correlation between education and off-farm activities.

Sex of the household head: Fikru (2009) showed that households headed by women have no significant differences with that of households headed by man in their adoption behavior of SWC technologies. Eleni (2008) and Krishhana, *et al.*(2008) indicated that the opposite was

true. Male headed households have a higher chance to be involved in continued use of SWC than female headed households because of women spend most of their time in domestic responsibilities.

Family size: physical conservation measures are labor intensive technologies. Studies conducted in Ethiopia indicated that for installation of recommended physical conservation measures about 70 and 50 person days per ha for soil and stone bunds, respectively, was estimated to be required (Wagayehu, 2003 and Habtamu, 2006). Woldeamlake (2003) identified that the lack of interest in SWC measures is due to shortage of labor. Geoffer (2004) found that household size was associated negatively with adoption of no conservation practice and positively with adoption of conservation practice. Others, studies conducted in Ethiopia indicated that larger family size has negative impact on the adoption of SWC technology (Bekele and Drake, 2003; Amsalu, 2006 and Fikru, 2009). The proponents of this view support their findings with the explanation that in a family with higher number of mouths to feed, immediate food need is given priority and, thus, labor is diverted to off-farm activities that generate food. Another explanation is when population increases, landholding per household was decrease which in turn has a negative on SWC adoption.

2.5.2. Socioeconomic Factors

Farm size-literatures suggest that the size of a farm has its own impact on farmer's decision towards the adoption of conservation measures. There is a tendency for farmers with large farms to invest on SWC technologies (Amsalu and Graff, 2006; Eleni, 2008; and Fikru, 2009). Farmers with small size farms tend to invest less on SWC technologies because of most conservation structures particularly the physical structures reduce the land that would be invested for crop production. Another explanation of previous studies was that farmers with a

large farmland get a high annual income that helps them to invest more on resource conservation.

Land ownership: - studies found the tendency that operators to use more conservation practices on land they owned compared to land they rented (Esseks and Kraft, 1989; Atakilte, 2003, Habtamu, (2006). Ervin and Alexander (1981), as cited by Habtamu (2006) observed erosion to be more sever on rented land than on owned. On the contrary, Bultena and Hiberge ,1983; Habtamu, 2006; Traore , 1998 and Habtamu, 2006 did not find a relationship between the way farmers accessed land (whether rented, leased or owned) and adoption of conservation measures.

Wealth status: - the wealth status of farmers was found to be positively correlated with the farmer's adoption of SWC measures (Norris and Eleni, 1987; Bekele and Drake, 2003; Kessler, 2006 and Eleni, 2006). According Bekele and Drake, (2003) the opportunity cost of labor for wealthier farmers is lower than poorer farmers, so that they can invest their available labor in SWC activities during slack labor season.

Availability of credit services: - study on the eastern highlands of Ethiopia, Bekele and Drake (2003) suggested that credit services for farm inputs and consumption helps to increase the adoption of conservation measures by farmers. Krishna *et al.*(2008) also found similar results. Accordingly the use of credit motivated farmers to produce more cash crops and get more income led to a better implementation of conservation measures. The result of Eleni in 2008 was different from the above findings: she concluded that access to credit was not the factor affecting the adoption of SWC works. The explanation was that farmers may use the money obtained from credit for purposes other than conservation measures.

2.5.3. Institutional Factor

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 positively 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 (Traore *et al.*, 1998; Habtamu, 2006).

Visits by development agents: - the existing literature holds two opposite views concerned with visits by development agent on SWC adoption. One view holds that contact with extension personnel increases the amount of variance explained in conservation tillage (Nowak,1987;Habtamu,2006).The study conducted in Ethiopia indicated that if a farmer receives better information/advice from extension agents, the farmer was willing to construct new conservation measures and to maintain the existing ones (Wagayehu and Lars, 2003). On the other hand, Fikru (2009) in his study on Koga watershed indicated that visits by development agents have no significant effect on the adoption of SWC technologies by farmers. Eleni (2008) has reached similar conclusion. She explained that the reason for this insignificant due to the fact that development agents is usually focused on matters other than conservation measures.

Training- training in a wide sense, including education and awareness rising, has been the main activity crucial for successful participation. The more educated and trained a person is the greater opportunity he/she has to participate in planning and decision making as well as project implementation (Lill, 1993; Tamiru, 1998).

Land tenure- in countries having a land tenure which is characterized by government ownership of land it is believed that there is a fear of losing landholding in the redistribution

(Shiferaw and Holden, 1998;and Admassie, 2000, Tadele, 2011).As a result of this farmers tend to invest less for any kind of investment on their plot. The degree of effective soil conservation is greatly influenced by land tenure. It is well known that uncertainty of land tenure leads to soil depletion, because farmers are not certain to their entitlements with regards to use the land, they try to maximize short term production grains and tend to dies regard long term investments(Afredo,*et al.*,1993;Yerasworq,1992;Tamiru,1998).Further more,the frequenter distribution of land caused farmers to feel insecure since they may lose parts of their farm (Keddeman,1989; Tamiru,1998),and this was have an impact on soil conservation activities (Singh *et al.*, 1993, Tamiru,1998).On the other hand studies in some parts of Ethiopia proved that the present land tenure system of the country have no significant effect on the farmers investment of any kind of technologies on their land (Bekele and Darke, 2003; Eleni, 2008; Fikru, 2009).

2.5.4. Physical Factors

Slope of the farmland- like rainfall and nature of soil that affects the rate and amount of soil eroded, slope of a field affects also the rate and amount of soil loss from fields (Tripathi and Singh, 2001; Habtamu, 2006).This influences farmers to control or mitigate the impact of erosion on fields that are situated at steep slopes and hence slope influences the decision of farmers to undertake conservation measures. The degree of slope positively affected the investment of conservation measures (Bekele and Drake, 2003; Amsalu, 2006; Eleni, 2008, and Fikru, 2009). Farmers cultivating steep slope fields install more effective conservation measures than farmers that cultivate level fields (Saliba and Bomley, 1986; Habtamu, 2006).

Soil fertility- 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 (Osgood, 1992

in Woldeamlake, 2003; Habtamu, 2006). On deep and/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 (Valk and Graaff, 1995; Habtamu, 2006). According to Eleni (2008) the level of soil fertility has a negative and significant correlation with the degree of SWC adoption. The explanation here is farmers may have interest to improve the level of soil fertility that are already exhausted and increase the productivity of their plot.

Proximity- farmers residing close to their cultivation land invest more on soil conservation measures than their counter partners living at a distance. Cultivation land closer to the residences receives more attention and supervision than that is situated at the farthest distance. Farmers also want to invest more in the field that requires least effort (Kessler, 2006; as cited Habtamu, 2006). According to (Gebrmedhin and Swinton., 2003) plot closer to homestead discouraged investment in soil conservation, Fikru (2009) also found similar results. Wogayehu and Lars (2003) found significant and negative correlation between no conservation decision and distance of a parcel from the residence but positive correlation between distance of the plot and adopting conservation decision

2.6. Empirical Studies on the Factors Affecting Adoption of physical SWC Practices

A number of empirical studies have been conducted by different people and institutions on the adoption and diffusion of agricultural innovations both outside and inside Ethiopia. Studies conducted in different authors indicate that farmers' adoption of physical soil and water conservation practices are determined by interactive effects of socio-demographic, economic, institutional and physical characteristics (Mesfine, 2015).

Study conducted by Addisu *et al.*(2015) on determinants of adopting techniques of soil and water conservation, reported that farmers who perceived introduced soil and water conservation structures to be more effective in controlling soil erosion and ensuring sustainability of yield make decision to adopt modern conservation techniques; and slope of the area, contact with extension workers, tenure status, age, size of the household and training influenced farmers to adopt soil and water conservation methods.

Study conducted by Habtamu (2014) on challenges of soil and water conservation practices and measures under taken in Wuchale district of North Shewa zone, Oromia regional state, showed that, slope of the area, tenure status, age, gender, education status of households, land size, lack of information, level of contact with extension agent, lack of awareness etc.; are influence farmers' practices of soil and water conservation structures.

Other studies made assessment of factors that determine adoption behavior of soil and water conservation measures in Libo Kemkem Woreda, by Solomon (2016) showed that, the major factors that were encouraging the farmers in adopting the introduced SWC measures on their plots of land were found to be perception of soil erosion as a critical problem, availability of labor, small land holding size access to extension services, land tenure security, participation and positive attitude of farmers towards introduced SWC measures.

A study conducted in Beressa watershed of Ethiopian Highlands by Aklilu (2006) identified factors that could influence adoption of different sustainable conservation techniques. This study was done using quantitative and qualitative research methodology and identified farmers' age farm size, perceptions on technology profitability, slope, livestock size and soil fertility to have an influence in the adoption of improved SWC practices. It further indicated the decision to continue using the practice was influenced by actual technology profitability, slope, soil fertility,

family size, farm size and participation in off-farm work. Factors such as perception of erosion problem, land tenure security and extension contacts were identified to have no significant influence.

Other studies made on assessment of farmers' adoption behavior status of improved soil and water conservation practices in Zala district, Gamo Gofa Zone, Southern Ethiopia by Terefe K. (2017) showed that, major factors that were influencing the farmers' adoption of improved soil and water conservation practices on their farm plot level were found to be educational status, family labor, total livestock unit, annual income, farmland distance and slope of the land.

2.7. Conceptual Framework of the Study

The dependent variable for this study was the adoption of physical SWC practices at farm level by farmers. The independent variables in this study area those variables which are thought to have influence on the adoption of SWC practices at farm level. Various factors that could be affect farmers' perception and adoption of physical soil and water conservation practices.

Among these factors, some have direct influence on perception and adoption of SWC where as others have indirect influence. These factors are demographic, physical, socio-economic, institutional and psychological factors. The framework generally indicates how the factors are interlinked and how they affect farmers' perception on adoption of SWC practices in the given area. In this study, farmers' perception on adoption of physical soil and water conservation is conceptualizing as to invest on physical SWC practices. Therefore, to achieve the objective of the research and to address the stated research question a conceptual frame work was developed on the basis of the above reviewed.

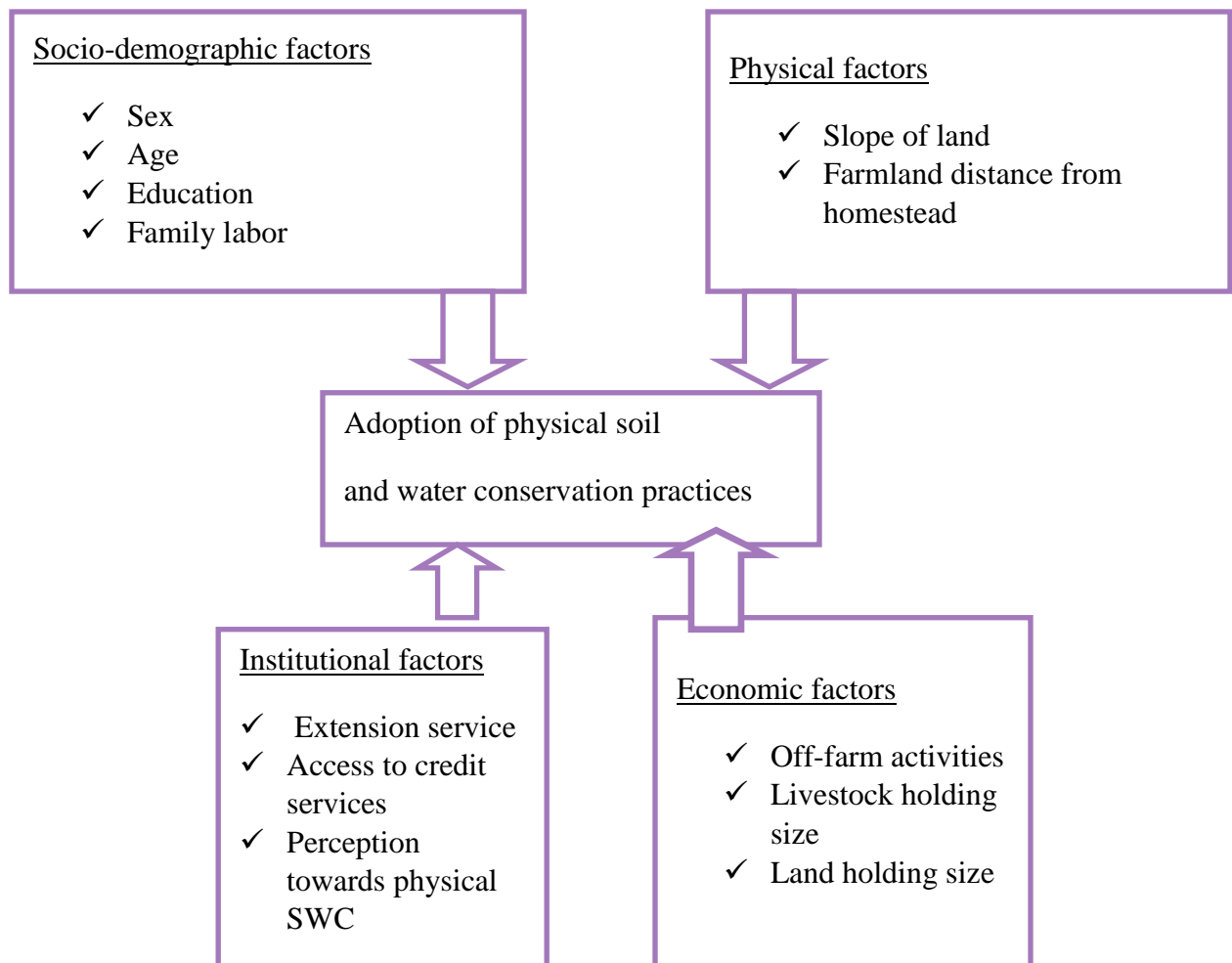


Figure 1: conceptual frame work of the study

Source: Modified after (Bekele and Drake, 2003; Solomon B., 2016; Terefe, 2017).

CHAPTER THREE

3. MATERIALS AND METHODOLOGY

3.1. Location of the Study Area

3.1.1. DESCRIPTION OF THE STUDY AREA

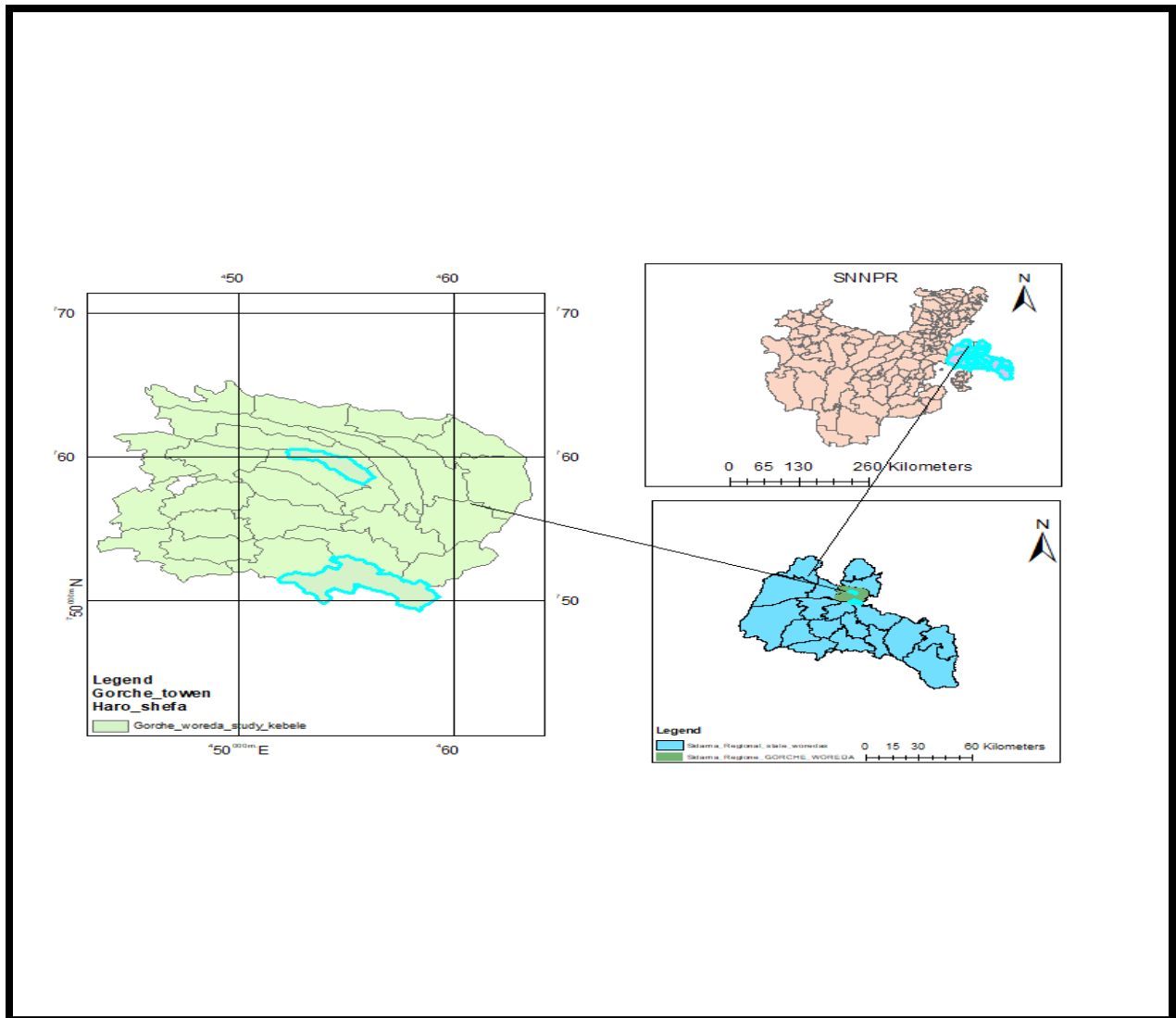


Figure 2 Map of the study area

Source: Developed by researcher by using of GIS software, 2021

In the sidama Regional State, Gorche Woreda is one of Woredas in Sidama regions of Ethiopia. The capital town of the woreda is Gorche it located 297 kilometers South of Addis Ababa and 27

kilometers South-west of regional city, Hawassa. It is located at 29°15'36" E to 33°06' 36" E and 3°54'36"N to 7°22'48" N. Gorche is bordered on the southwest by Wensho, on the west by Shebedino, on the north by Malga, on the east by the Oromia Region, and on the southeast by Arbegona. Gorche was separated from Shebedino woreda. The altitudinal range of the woreda from 1501-3000 masl (CSA, 2007) The agro-climatic Zone of the Woreda consists *Woinadega* (22%) and *Dega* (78%). The mean annual rainfall reaches from 1201mm to 1600mm and the average temperature varies from 4.10⁰c-22.4⁰c. Accordingly, it has two rainy seasons these are Kiremt (summer) and Belg (autumn). Most of the rainfall is received during June–September and the short rainy season (autumn) extends from March - May and the highest temperature is received during December, February and March (NMA, 2019). The soils of the study area are predominantly Leptosols, Nithosols, Vertisols and Luvisols (Soil FAO and eth, 2007). Gorche is characterized by plain, mountainous, ups and down, depression and swampy areas which account 42%, 21%, 30%, 1% & 6% respectively (GWANRO, 2021). According to the Woreda environmental protection, land administration office annual report (2021), the total area of the Woreda is about 18,177 hectares. Areas covered by bush, shrubs and natural forests are found in the areas. The general land uses described as follows (table1):

Table: 1. Land use and land cover in Gorche Woreda

Land use	Area in hectares	%
Cultivation land	12465	68.56
Grazing land	2061	11.34
Forest land	838	4.61
Water body	112	0.61
Construction and other services	750	4.13
Others	1951	10.7
Total	18177	100

Source :GWAO ,2021

3.1.2. Population and Socio-Economic Conditions

According to CSA (2007), the total population of Gorche Woreda is estimated 105,472, of whom 53,484 were men and 51,988 women; 2,986 or 2.83% of its population were urban dwellers of which 55,676 are men and 54,117 are women. The *woreda* is mostly inhabited by Sidama people and predominantly the majority of the inhabitants were Protestants, with 78.92% of the population reporting that belief, 6.61% observed traditional religions, 6.48% were Muslim, and 5.81% were Catholic. The economic bases of the community in the *woreda* were the rain fed and irrigation agricultural practice. Mixed agriculture remains to be the main livelihood basis. The major crops grow in the study area includes wheat (*Triticum* sp.), potato (*Solanumtuberosum*), and barley (*Hordeum* sp.), bean (*Viciafabia*), Onion (*Allium Cepa*), Enset, chat and maize (*Zea mays*). The average household land holding size was 1 hectare. Agriculture is an important livelihood resource that plays significant role to household sustenance, income generation. Cattle, sheep, goat, pack animals and poultry are the most common domestic animals raised in the rural area (GWANRDO, 2021). In addition, there is the production of honey in the study area. During the market day, the people from different localities come and exchange agricultural products, manufactured goods, clothes, different animals etc. in order to put in practice, the socio-cultural activities and to solve problems, the community has different traditional social and cultural organizations like Mahiber, Eder, Ekub and Yehager Shimaglie (local elders) Gorche Woreda Communication Office, 2021).

3.2. Research Design

Research design is the conceptual structure within which research was conducted. The study used cross-sectional designs with quantitative and qualitative data type to answer research questions of the study.

3.3. Sampling Technique and Sample Size Determination

The study used multi-stage sampling procedure as the major method of sampling to select the sample respondents. From 30 rural Woreda and 6 urban administration of Sidama Region, Gorche Woreda was selected purposively by the researcher because of his familiarity with the area, experience to the problem of soil erosion and low adoption of physical soil and water conservation practices. The Gorche Woreda was stratified into Dega (78%) and Woyinadega (22%) agro-ecological zone. It has a total of 27 *kebeles*, 3 of them are urban *kebeles* administrations and 24 are rural *kebeles* administrations. From this rural *kebeles*, 7 *kebeles* found under Woyinadega traditional climatic zone and 20 *kebeles* under Dega traditional agro-climatic Zone. One *kebeles* from Woyinadega (Gorche town), one *kebeles* from Dega (Haro-shefa) and a total of 2 *kebeles* was randomly selected from each class for the study. To identify sample respondents' household farmers from each sampled *kebeles*, proportional sampling technique was employed. After selecting the sample *kebeles*, researcher tried to determine the sample size using the statistical procedures. Consequently, the study adopts a simple mathematical formula used by Yamane (1967) for determining sample size.

The formula for sample determination at 95% confidence level, 5% degree of variability and 8% level of precision are described as follows:

$$n = \frac{N}{1 + N(e)^2}$$

Where: n=sample size

N=the populations

e=the acceptable sample error

Using the total population of 1248 and to reduce house hold sample size error margin of 0.08 employed. The sample size is calculated as follows:

$$n = \frac{1248}{1 + 1248(0.08)^2} = 138.86 \approx 139$$

Table2. Number of respondents in each of selected agro-ecological zone of sampled rural Kebele's was:

Sampled Rural kebele	agro-climatic zone	Male HH	Female HH	THH	sample of MHH	sample of FHH	Total sample of HH
Haro-shefa	Dega	514	126	640	57	14	71
Gorche towne	W/dega	483	125	608	54	14	68
Total		997	251	1248	111	28	139

(Source: Own survey, 2021).

3.4. Types and Source of Data

The study used both primary and secondary types of data. The primary data were collected from sample farming households by using structured interview questionnaires. In addition to this, focus group discussion and key informants' interview was also conducted to get more additional information on the research objectives. Whereas secondary data were obtained from published and unpublished sources such as agricultural offices reports, internet, journals articles, different reports, published books and MA/MSc and PhD thesis.

3.5. Methods of Data Collection

The researcher used different data collection methods to attain the objectives of the study. The quantitative methods involve the use of household survey (questionnaire) while the qualitative methods include: focus group discussion, key informant interview.

Questionnaires: is a typical method to collect primary data from the sample households. A structured interview questionnaire that have involved both closed ended and open ended questions are prepared and used to generate data from the respondents. The questionnaire was translated into the local language (Sidamigna) to make the question simple, clear and understandable to the farmers/respondents. Household survey was conducted through face to face interview of the respondent by enumerators.

The survey questions was covered a wide range of information which includes the cause and consequences of soil erosion, household characteristics such as (age of household heads, sex, education status, family size and HH heads plan to continue as farmer); socioeconomic conditions of households (livestock holding and off-farm income); institutional factors (training about SWC, access to extension services, access to credit) and physical factors (farm size, slope of a parcel, and proximity of farm land). In additional to this the structures implements at farm level were also explored with plot level observations.

Key informants Interviews (KII): Is additional method that is used to collect primary data. It was used to collect in-depth information about improved soil and water conservation technologies, supports of government in the adoption ISWCTs and their perception about the problem. The information is gathered through key informants is used to harmonize and supplement the data collected from household survey through structured questionnaire. Interview is conduct with key informants such as elder people who had lived and worked for long time in the study area, *kebele* leaders, SWC supervisors and Development Agents (DAs).

Focus group discussion (FGD): is another most important data collection technique used to collect qualitative data by preparing discussion questions about farmer' perception and adoption on ISWCTs. FGDs are held with selected model farmers of the sample *kebeles*, religious leaders,

agriculture extension workers, SWCTs supervisors youth league and women league federation. There were two focus groups. Each group would have been ten (10) members.

3.6. Methods of Data Analysis

The study used both quantitative and qualitative data analysis techniques. Concerning to the quantitative data analysis, after the data were gathered through survey questionnaire, it was coded, edited and entered in to the statically package for Social Sciences (SPSS) version 24 software where descriptive statistics, frequencies, percentages, chi-square test, T-test, mean, standard deviations and binary logistic regressions were used for the analysis.

T-test was employed to analysis the difference between means of two independent samples. That is helpful to compare adopters and non-adopters of improved soil and water conservation technologies with respect to continuous variables such as age, family labor, total farm size in hectare and tropical livestock unit. Chi-square test also used to show relationship between the adoption decision of farmers and the categorical explanatory variables such as sex, education status, and extension service, access to credit, slope of land, farm land distance and off-farm activities.

Farmers' perception towards soil conservation as a problem was analyzed using Likert scale by summing up the reaction of positive (+ve) and negative(-ve) response to a list of questions that seek knowledge, experience, and exposure of farmers about improved soil and water conservation. To achieve this, a five point Likert scale containing items with response categories ranging: strongly agree, agree, no opinion, disagree and strongly disagree for favorable statements questions were developed, while the scoring was reversed for

unfavorable statements. The respondents were asked to indicate which option best describe their opinion with respect to the questions asked for the perception analysis, respectively.

On the other hand, the qualitative data from key informants interview and focus group discussion was analyzed through narration. Finally, binary logistic regression model was employed using SPSS version 20 to analyze the factors which affect dependent variables.

3.6.1. Descriptive and Inferential Statistics

Both descriptive as well as inferential statistics were employed in the analysis. The descriptive analysis includes frequency, means, ratios and percentages were computed for different variables. Independent t-test was used to detect differences in the mean of one variable between two groups of the households. The chi-square test is run to detect any systematic relationship between dependents variable of interest and specific household characteristics. With regards to econometric analysis, a binary logistic regression model was used. The key question is what factors are associated with farmers' perception and adoption of improved soil and water conservation technologies.

3.6.2 Econometric Model

The binary independent variables and a binary choice model assume occurrences between two alternatives (between adopters and non-adopters of improved soil and water conservation technologies). For this particular study, logit model was selected. The linear probability model (LPM) which is expressed as a linear function of the explanatory variable is computationally simple. However, despite its computational simplicity, stated by Gujarati (2004). Hence logit model is advantageous over LPM in that the probabilities are bound between 0 and 1. Moreover, logit best fits to the non-linear relationship between the probabilities and the dependent variables.

For binary random variable Y assuming value either 0 or 1, the probability (Y=1) is

$$P_i = E(Y) = \frac{1}{X_i} = \beta_0 + \beta_i X_i \quad \text{equ(1)}$$

Where Y=1 means a given farmer participates in improved soil and water conservation practices

X_i is a vector of independent variables

β_0 is the constant and $\beta_i, i = 1, 2, \dots, n$ are the coefficients of the independent variables to be estimated.

$$P_i = E(Y) = \frac{1}{X_i} = \frac{1}{1 + e^{-(\beta_0 + \beta_i X_i)}} \quad \text{equ(2)}$$

$$P_i = \frac{1}{1 + e^{-z_i}} = \frac{e^z}{1 + e^z} \quad \text{equ(3)}$$

Where $Z_i = \beta_0 + \beta_i X_i$

If P_i is the probability of being adopter and $1 - P_i$ is the probability of being non-adopter of soil and water conservation technologies.

$$1 - P_i = \frac{1}{1 + e^{z_i}} \quad \text{equ(4)}$$

Therefore, we can write this equation as

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{z_i}}{1 + e^{-z_i}} = e^{z_i} \quad \text{equ(5)}$$

Later, $\frac{P_i}{1 - P_i}$ is the odds ratio of adopter farmers with the ratio of the probability that a given farmer participate in soil conservation practices to the probability that the farmer who are

participating in soil conservation. Then, if we take the natural logarithm of equation (e) we obtain

$$Li = Ln \left[\frac{P(i)}{1 - P(i)} \right] = \ln \left[e^{\beta_0} + \sum_{i=1}^m \beta_i + x_i \right] = Z(i)c \quad \text{equ(6)}$$

If the disturbance term U_i is taken in to account, the logit model becomes

$$Li = Z(i) = \beta_0 + \sum \beta_i x_i + u_i \quad \text{equ(7)}$$

Consequently, Li , which is the log of odds ratio, is called logit or logit model (Gujarati, 2004). Hence, the above Logit Model was employed to estimate the effect of the hypothesized independent variables on adoption decision of farmers to use soil and water conservation technologies.

Before taking the selected variables into the logit model, existence of multi-collinearity among the continuous variables was seen and association among the dummy variables was verified. To avoid the problem of multi-collinearity, both continuous and dummy variables were checked prior to executing the logit model. Different methods are often suggested to detect the existence of multi-collinearity problem. Among them, variance inflation factors (VIF) technique was employed to detect multi-co linearity in continuous independent variables (Gujarati, 1995) and contingency coefficient (CC) for dummy variables.

According to Gujarati (1995) VIF (X_i) can be defined as

$$VIF(x_i) = \frac{1}{1 - R_i^2} \quad \text{eq(8)}$$

Where: $-R^2$ are the multiple correlation coefficients between X_i and other explanatory variables.

For each selected continuous explanatory variable, (X_i) is regressed on all other continuous explanatory variables, the coefficient of determination (R_i^2) constructed for each case. The highest value of R_i^2 , the highest the value of VIF (X_i) causing highest co-linearity in the variables (X_i). For continuous variables according to Gujarati (1995), if the value of VIF is 10 and above, the variables are said to be collinear (if the value of R^2 is 1, it would result in higher VIF and causes perfect multi-co linearity between the variables). Whereas for dummy variables according to Healy (1984), if the value of contingency coefficient greater than 0.75, the variables said to be collinear. In the same line, contingency coefficients were computed for dummy variables from chi-square (χ^2) value to detect the problem of multi-collinearity (the degree of association between dummy variables).

$$C.C = \sqrt{\frac{\chi^2}{n + \chi^2}} \quad eq(9)$$

Where: C.C = Contingency coefficient, n= sample size, χ^2 =Chi-square value

3.7. Definition of Variables and Hypothesis

3.7.1. Dependent variables

Dependent variable is a variable that is said to be affected or explained by another variable. The dependent variable for this study was to assess the adoption of improved soil and water conservation technologies. This variable is hypothesized to be affected by the independent variables such socio-demographic, economic characteristics, physical factors, institutional factors, and psychological factors. As it was discussed in, Rogers's function of innovation decision (1983) the adopters should be aware of innovation first and after perception and attitude development, adoption would be taken place.

3.7.2 Independent variables

Independent variables are variables which influence or affect dependent variables positively or negatively. In this study independent variables represent the variables that affect adoption of improved soil and water conservation technologies. These independent variables include: age of household head, sex of household head, education level, family labor, land holding size, off-farm income, livestock holding and farm land distance from homestead, extension contact, credit service, slope of the cultivation land and perception towards soil erosion.

Based on literature reviewed and authors experience the following independent variables were hypothesized:

Age of household head: This variable is continuous variable measured in years. According to the previous studies, as age of household head increases, he/she becomes unwilling to adopt conservation structures at most (Terefe, 2017).

Sex of household head: The sex of the household heads was including difference between male and female in the variation of ISWC practices. It is nominal variable used as dummy, which take a value of one if male, zero if female. Male headed households are expected to better undertake different soil and water conservation practices, as better endowed with labor. Female headed household are also sometimes inhibited from making decisions about land management practices while their husbands are away (Benin, 2006). Therefore sex of household was hypothesized to positively influence adoption of soil and water conservation structures if in favor of male.

Educational Status of the household head: (a dummy variable where 1=illiterate, 0= literate): This is educational attainment of the household head. It is expected that those farmers with better educational attainment perceive the problem better and make decision to retain conservation

practices. Hence education status of HH is expected to be positively significant with adoption of physical SWC practices.

Family labor: This variable is a continuous variable. The ability of the farmers to adopt conservation technologies is primarily related to their labor supply. The larger the family size, the better the labor force availability adopt soil and water conservation measure and vice versa. Therefore, the researcher hypothesized that family labor may influence adoption of soil and water conservation practice positively.

Land holding size (Farm size): Is a continuous variable which measured in hectare. Farmers that have large farm size are considered to be wealthier so that they can invest more on soil and water conservations. 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 (Habtamu, 2006).

Off-farm activities (off-farm): (Dummy variable 1, if a household involved in off farm activities; 0, otherwise): 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 decision to adopt conservation structures (Terefe, 2017).

Livestock holding: This variable is a continuous variable represents the livestock holding of a household measured in Tropical Livestock Unit (TLU). Livestock is an indicator of wealth, source of income to purchase agricultural inputs, source of draft power that in turn increases the farmers' opportunity to invest on soil and water conservation. The past adoption studies which have reported positive effect of livestock holding on adoption of soil and water conservation

measure (Mesfine, 2015). Therefore, in this study the researcher hypothesized positive influence on adoption of soil and water conservation practices.

Farm land distance: This variable is a categorical variable (near < 20min, far 21-30min and very far >30min) that represents how much far the parcel is situated from the residence. According to the most of the literature, farm land situated near the residence the farmers receive better attention (Mesfine, 2015). Hence it is hypothesized that the distance influence farmers' decision to adopt soil and water conservation measures negatively.

Slope of the cultivated land: Slope of land a household cultivates (1, if flat; 2, if gentle slope; 3, moderately sloping; 4, steeply sloping (Habtamu E., 2006). These slopes categories of cultivated land according to how farmers in the study area categorize slopes of the cultivation land. According to most of the literature, farmers that have farm plots on steeper location are more likely to use conservation measures than farmers on flat areas (Mesfine, 2015). It is expected that slope influences farmers' decision to adopt conservation structures positively. Therefore, the researcher hypothesized that slope of farm land may influence adoption of soil conservation practice positively.

Extension contact: This variable is a dummy in nature that takes a value of a value of 1 if a household has an extension services and 0 otherwise. Access to extension services by development agent has a positive influence on adoption of soil and water conservation measures because farmers who have access to extension services get training that enhance their knowledge (Selomon, 2016).

Access to credit: (a dummy variable 1, if the household has access to credit and 0, if not): It is the availability of credit from micro-finances. The access to credit systems increased farmers'

ability to invest on his/her land. Thus, it is hypothesized that access to credit has positive relationship with adoption of soil conservation technologies (Terefe, 2017).

Perception towards soil erosion: It is a dummy variable used to measure farmers’ perception of the presence of soil erosion problem in his/her farm plots. It takes a value of 1, if a household head has positive response to soil erosion problem in his/her farm plot, and 0 if negativity. A farmer who perceives presence of soil erosion on his farm land and its effect on productivity is more likely to use conservation practices. Farmers’ decision to participate in conservation practices are positively related to perception of soil erosion problems (Aklilu and Jan de, 2006).

Table3. Summary of independent variables, measurement scales and relationships

Description of variables	Type	Unit of measurement	expected effect
Age of households	Continuous	Number of years	+ or –
Sex of households	Dummy	1 if male and 0 if female	+
Education level	Dummy	1 if literate and 0 illiterate	+
Family labor	Continuous	Number of household in man equivalent	+
Size of land holding	Continuous	Hectare	+
Number of livestock	Continuous	Number of livestock in TLU	-
Off-farm activity	Dummy	1 if participate; 0 = otherwise	-
Access to credit	Dummy	Participation in credit (1 if participate; 0 = otherwise)+	
Extension services	Dummy	1 if participate; 0 = otherwise	+
Farm land distance	Categorical	1, near; 2, far;3, very far	-
Slope of land	Categorical	1, flat; 2, gentle; 3, moderate; 4, steep slope	+
Perception toward ISWCTs	Dummy	1, if farmers’ perception erosion as problem;0 otherwise	+

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. Socio-Demographic Characteristics of the Respondents

4.1.1. Age of household heads and family labor

Age is one of the household demographic characteristics which is important to describe the households and can provide clue age structure of the sample respondents. Table 4 revealed that the mean age of non-adopters and adopters of the sample households was 44.44 and 43.16 with standard deviation of 12.22 and 11.12 respectively. The descriptive result indicates that the mean age of adopters was less than that of non-adopters. This shows younger household heads were more likely to adopt physical SWC practices than old household heads. The age difference between adopters and non-adopters was found to be statistically significant at 1% level. However, the finding of (Belete Limani Kerse, 2017) contrary our finding. The finding of Long (2003) and; Wagayehu (2003) agree our finding. According to Long (2003) and wagayaehu (2003) these scholars soil conservation requires longer period and puts land out of production. Furthermore, older farmers lack labor required to maintain conservation structures installed. Hence, these situations affect farmers' attitude negatively on soil conservation structures.

Table4. Sampled household age and family labor categories by adoption groups

Description	Non-adopters		Adopters		Total		T-test	
	Mean	S.D	Mean	S.D	Mean	S.D	t-value	p-value
Age	44.44	12.22	43.16	11.12	43.8	11.62	44.7*	0.000
Family labor	3.35	0.994	3.51	0.994	3.42	0.992	4.614	0.000*

Source: Own survey, 2021 * statistically significant at 1% significant level

The ability of farmers to adopt physical soil and water conservation practices is primarily related to their labor supply. According to survey result the average family labor in terms of man

equivalent of sample households was 3.42 persons with standard deviation of 0.992. The family labor for adopters and non-adopters was 3.51 and 3.35 with standard deviation of 0.994 and 0.991 in man equivalent respectively. This shows that non-adopters had lower number of family labor than adopters (Table 4). This further implies that a household's labor supply determines its ability to construct soil and water conservation structures. Households with small number of family labor were less likely to adopt physical SWC measures than households with more family labor. Research report by Terefe (2017) agrees with this report. The study report indicated that, farmers with larger family labor were more likely practiced physical SWC practices than household with small number of family labor. The t-value result showed that, there was a statistically significant relation between adopters and non-adopters of soil and water conservation in terms of family labor.

4.1.2. Sex and Educational level of household heads

The total numbers of sample households used for this study were 139. They were categorized into non-adopters 61 (43.9%) and adopters 78 (56.1%). From the above sample households, 111 (79.85%) were male and 28 (20.14%) were female household heads (Table 5).

Based on the survey, 68 (87.17%) of the adopters were male headed households and 10 (12.82%) were female household heads. On the other hand, out of the non-adopters 43 (70.49%) were male and 18 (29.50%) were female headed households. Chi-square tests at level of significance were taken to understand the degree of association between sex and adoption of ISWC practices. Accordingly, there was significant relationship between adoption of physical SWC practices and household head sex at [$\chi^2 = 49.561$ (DF=1, P=0.000)]. According to focus group discussion the male household heads participated more actively than female household heads in physical SWC

practice because female household heads have more responsibilities at home. They were highly involved in regular household activities than men. This result is in line with the argument that male headed households are often considered to be more likely to get information about new technologies and take risky businesses than female-headed households (Abay and Asefa, 2004). However, this result contradicts the findings of Apata et al. (2009) who argued that sex has no statistically significant relationship with the implementation tendency of household to implement different soil and water conservation structure strategies. Nhemachena and Hassan (2008) have found that female headed households were more likely to take up technologies adaptation methods than male in assessing determinants of African farmers' categories for adapting to climate change.

Eleni, 2008 and Krishna *et al.*, (2008) in their research stated that, male household heads had more chances to involve in physical SWC practices than female household heads. This is because most women in the study area spent their time in domestic responsibilities and activities.

Table 5: Association between sex and Education level of Household heads and adoption of physical SWC practices in the study area

Sex of HH	Frequency		Adopters		Non-adopters		DF	Chi-square test	
	N	%	N	%	N	%		X ²	P-value
Male	111	79.85	68	87.17	43	70.49			
Female	28	20.14	10	12.82	18	29.50	1	49.561	0.000*
Total	139	100	78	100	61	100			
Educational Level									
Literate	54	38.8	36	46.2	18	29.5			
Illiterate	85	61.2	42	53.8	43	70.51	1	6.91	0.00*
Total									

Source: Own survey, 2021 *statistically significant at 1% level

The level of education is one of the social factors of households which play crucial role to increase farmers' knowledge and adoption of soil and water conservation practices. In the study area sample respondents were categorized in to literate and illiterate based on their educational background. Consequently, from the total number of respondents, 54 (38.8%) were literate while 85 (61.2%) were illiterate. As indicated in table 6 out of the total 36 (46.2%) and 42 (53.8%) were adopters and 18(29.5%) and 43(70.5%) non-adopters were literate and illiterate respectively. Chi-square test confirmed that the education level between adopters and non-adopters were statistically significant at 1% level. These shows educational statuses of the household heads positively affect the adoption of physical soil and water conservation practices. This result is in line with the (Belete, .2017) who concludes that having formal education improves the decision making power of a household to engage or not in activities especial

externally driven interventions. In other word, education influences farmer's decision to adopt technologies by enhancing farmer's ability to adapt to it. In this study result, education was found to affect continued use of soil and water conservation technologies positively. The positive association shows that better educated households seem to decide to retain conservation structures better than low level of the uneducated household. This implies that education may enable farmers to easily understand and recognize the problem of soil erosion, able to change and put into practice the knowledge and skill they obtained from extension services and other sources. In additional to this Long (2003) obtain the same result by your study. However, the study made by Bekele (1998) in Ethiopia showed education is negatively related to the desire and capacity of adopting soil and water conservation structures.

4.2. Economic Characteristics

4.2.1. Farm land holding

The total farm size owned by households is taken as proxy to economic status. The average mean of adopters and non-adopters were 0.63 and 0.38 with standard deviation of 0.51 and 0.45 respectively. This implies that non-adopters had small farm land size than adopters. The study indicated that, farmers with larger farm land size are more likely practiced long-term improved SWC practices, while farmers with less farm size are less likely to practice physical SWC measures. Amsalu and De Graaff (2006) similarly found that farmers who have a larger farm are more likely to invest in soil conservation measures because they have the funds to do so. Moreover, t-test results of the analysis showed that the relationship between adopters and non-adopters of soil and water conservation practices was found to be statistically significant at 1%.

Table: 6 Farm land holding and livestock ownership adoption of SWC practices

Description	Non-adopters		Adopters		Total		T-test	
	Mean	S.D	Mean	S.D	Mean	S.D	t-value	p-value
Farm land H.	0.38	0.45	0.63	0.51	0.50	0.48	14.96*	0.000
TLU	6.40	3.74	4.35	3.44	5.37	3.56	21.075	0.000*

Source: Own survey, 2019 Farm land holding * statistically significant at 0.01 significant level. However, Livestock ownership is not *statistically significant level.

The most important components in farming system are the breeding of livestock for different purpose such as; farming activity, source of income, means of transportation and source of food. Livestock that were found in the study area include Cattle, Goat, Sheep, Donkey, Horse, Mule and poultry were the most common. In the study area the wealth of the household heads were described by the number of livestock.

The mean livestock populations of the respondents were 5.37 TLU with standard deviation of 3.56. Survey result showed that maximum and minimum livestock holding in the study area were 20 and 0 TLU respectively. As indicated in Table9, the average of adopters had less livestock (4.35) than the non-adopters (6.40) in TLU. This refers that farmers with small number of livestock adopted physical soil and water conservation practices better than the farmers with large number of livestock.

The result of the t-test at 1% level of significance ($t=21.075$, $p=0.000$) indicated that, there was a significances difference between adopters and non-adopters in terms livestock holding (Table 6)

4.2.3. Off-farm activity

Participation in off- farm activities is common in the study area. Some of them involved in daily labor work, fire wood selling, handicrafts, metal work and petty trade. These off-farm activities served as a source of additional income to cover cost of home consumption products, for buying agriculture fertilizers, different cattle and clothes (Solomon, 2016).

Based on the survey, 31.6% of household respondents participated in off-farm jobs while 68.3% did not engage in such activities (Table 7). Among the total respondents, 11.5% of the adopters participated in off-farm activities where as 57.4% of the non-adopter respondents participated in off-farm activities. On the other hand, 88.5% and 42.6% of the adopters and non-adopters did not involve in off- farm activities respectively. Farmers who were participating in off-farm activity had lower chance to participate in the adoption of physical SWC practices than those who were not participating in off-farm activities.

Table7: Off-farm activities and adoption of ISWC practices

Participation in	Frequency		Adopters		Non-adopters		df	Chi-square	
	N	%	N	%	N	%		x ²	p-value
Yes	44	31.6	9	6.47	35	25.17			
No	95	68.3	69	49.6	26	18.71	1	2	0.000*
Total	139	100	78	100	61	100			

Source: Own Survey, 2021 * statistically significant at 1% level

4.3. Institutional Characteristics

4.3.1. Access to extension services

One of the widely used means of addressing information to the rural part of Ethiopia is public extension service. Development agents are responsible to disseminating the information for each kebeles to provide extension services. Farmers pointed out the governments' extension service as the most important one in disclosing the information particularly about agriculture related practices. Input supply, land use and land management practices; improved cultural practices and ISWC practices are among the aspects covered by the extension services.

As presented in Table 11, 54.7% of the respondents contacted with extension service workers but, 45.3% of farmers did not. From the adopter respondents 47.43% have access to extension services and only 36.06% of the non-adopters not got extension service. This implies that, if farmers did not have enough amount of contact with extension service workers, they might not have adopted physical SWC practices.

The chi-square test [$\chi^2 = 1.216$ (DF=1, p= 0.027)] indicates that access to extension services had significant influence on the adoption of ISWC practices. The finding was similar with the study of Solomon Birhanu (2016), Desta (2012), Simon *et al.*,(2012) and Tesfaye *et al.*,(2013) stated that less adoption of physical SWC practice is related to lack of appropriate extension services.

Table8: Access to extension service related to adoption of SWC practices and HH access to credit service and adoption behaviors SWC practices.

Access to Extension Service	Frequency		Adopters		Non-adopters		df	Chi-square test	
	N	%	N	%	N	%		X ²	p-value
Yes	76	54.7	37	47.43	39	63.93			
No	63	45.3	41	52.56	22	36.06	1	1.216*	0.027
Total	139	100	78	100	61	100			
Access to Credit Service									
Yes	34	24.46	19	24.36	15	24.59			
No	105	75.54	59	75.64	46	75.41	1	36.266*	0.00
Total	139	100	78	100	61	100			

Source: Own Survey, 2021: Acc to extension services statistically significant at 5% level and access to credit services is significant at 1% level.

Lack of enough access to credit had a negative impact on the adoption of new technology, agricultural productivity, health and nutrition (Diagne& Zeller 2001). Similarly Bekele&Drake, (2003) stated that credit services for inputs and consumption helped to maximize the adoption of conservation measures. But Eleni, (2008) concluded that access to credit was not a significant factor affecting farmers decision on the adoption of physical SWC practices, because they might use the money for different purpose other than physical SWC practices.

Based on the survey, it was founded that (24.46%) of household members had access to credit while the majority of the respondents (75.54%) did not get credit from any institutions. On the other hand, 24.36% and 24.59% of the adopters and non-adopters have obtained credit whereas, 75.64% and 75.41% of the adopters and non-adopters have not obtained credit from any institutions respectively. This shows that, the households who have an opportunity to credit have

higher probability of adopting SWC practices than those with no credit access. The chi-square test at 1% level significant [$\chi^2 = 36.266^*(df = 1, p = 0.000)$] indicates that access to credit services had significant influence on the adoption of SWC practices.

4.4.1. Homestead farmland distance: One of the major factors that determine the adoption of soil and water conservation measures was distance between residence and farm land areas of household heads. The distance that household heads travel was classified in to near, far and very far. Farm plots near homestead have always supplemented with farm yard manure and better in soil fertility status than fields away from homestead. The focus group discussions and key informant interviews result indicated that farmers having land far from their homestead usually does not visit their farm land except during land preparation, planting, weeding and harvesting.

The survey result in Table 13 indicated that 39.7%, 46.1% and 14.1% of the adopter and 11.5%, 52.5% and 36.0% of the non-adopter cultivated near, far and very far respectively. This shows that, the farmers who live near to their homestead have more chance to adopt soil and water conservation practices than those of far to their homestead. The chi-square test at 1% level significant [$\chi^2 = 15.468^*(df = 2, p = 0.000)$] indicates that farm distance from homestead had significant influence on the adoption of SWC practices.

Table9: Farm distance of farm land from homestead and slop of farm land

Distance from Homestead(min.)	Frequency		Adopter		Non-adopter		df	Chi-square test	
	N	%	N	%	N	%		X ²	p-value
Near<20	38	27.3	31	39.7	7	11.5			
Far 21-30	68	48.9	36	46.1	32	52.5			
Very far>30	33	23.7	11	14.1	22	36.0	2	15.468*	0.000
Total	139	100	78	100	61	100			

Slop of farm land										
Flat	36	25.9	16	20.5	20	32.8				
Gentle	43	30.9	22	28.2	21	34.4				
Moderate	31	22.3	19	24.4	12	19.7	1	3.360*	0.000	
Steep slope	29	20.9	21	26.9	8	13.1				
Total	139	100	78	100	61	100				

Source: Own Survey, 2021 *significant at 1% significant level

It is another physical component that determines the adoption of SWC measures by household farmers that were classified as flat, gentle, moderate and steep slopes. The survey result in Table14 indicated that 7.69%, 28.20%, 37.17% and 26.92% of the adopters and 32.78%, 34.42%, 19.67% and 13.11% of the non-adopter farmers' farm lands were found flat, gentle, moderate and steep slope respectively. From slope point of view the farmers who had farm land moderately and steep slope understood the impact of soil erosion on their farm land. As a result, farmers who had this type of land slope highly used to construct SWC structure. This result was line with the findings of Terefe (2017), stated that farmers cultivating sloppy lands were more

likely to adopt soil and water conservation practices than those cultivating less vulnerable type of slope fields. The Chi-square result indicates that slope of land had significant influence on the adoption of SWC practices.

4.5 Current adoption status of Physical SWC Practices in the Study Area

Farmers in the study area were adopted different physical soil and water conservation practices. As indicated in Table 15 respondents had adopted different physical soil and water conservation practices in order to control soil erosion and to improve agricultural productivities. Among physical SWC practices soil bund, hillside terrace, cut-off drain and rainwater harvesting were adopted in the study area.

4.5.1. Improved soil bunds: They are structures constructed along the contours of farm lands. Reduction of runoff speed, accumulation and protection of soil on farm plots are the effect of these structures. Improved soil bunds are less permanent and less durable structures compared to improved hillside terrace and cut-off drain. Soil bunds are mostly applied on rain fed flat and gentle slopes in the study area. As its name implies, soil bunds are constructed totally from soil with the use of either family labor. Hand shovel, locally known as (akafa and wenencho) are the main farm tools used for the construction of improved soil bunds. They are constructed during dry season before land preparation. But it was undertaken by about 75% of the sample households (Table10)



Source: Own plot survey, 2021

Figure 3. At Gorche woreda farm plot implement soil bund conservation structures

4.5.2. Cut-off drain: Improved Cut off drain is one of the physical structures commonly constructed by digging the soil deep in order to divert the run off before reaching the farmland. The survey result shows that about most of the farmers have been practicing cut-off-drain with soil and water conservation practices. The farmers construct such structure in order to prevent loss of seeds, fertilizers, and soil due to excessive run-off coming from uplands of the terrain and dispose the excess water from the field (Table 10)

4.5.3. Hillside terrace: It is a physical structure constructed in mountainous areas with steep slope and shallow soil to protect enclosure areas to control run-off, allow sufficient time for percolation of surface flow, maintain soil fertility, filter sediments and remove excess water low. These allow the enclosure areas to recover by natural and other conservation process. In the study area, the area where this technique was practiced is closed, in order to improve the land

affected by severe erosion, limited vegetation and low fertility through natural regeneration (Table10)

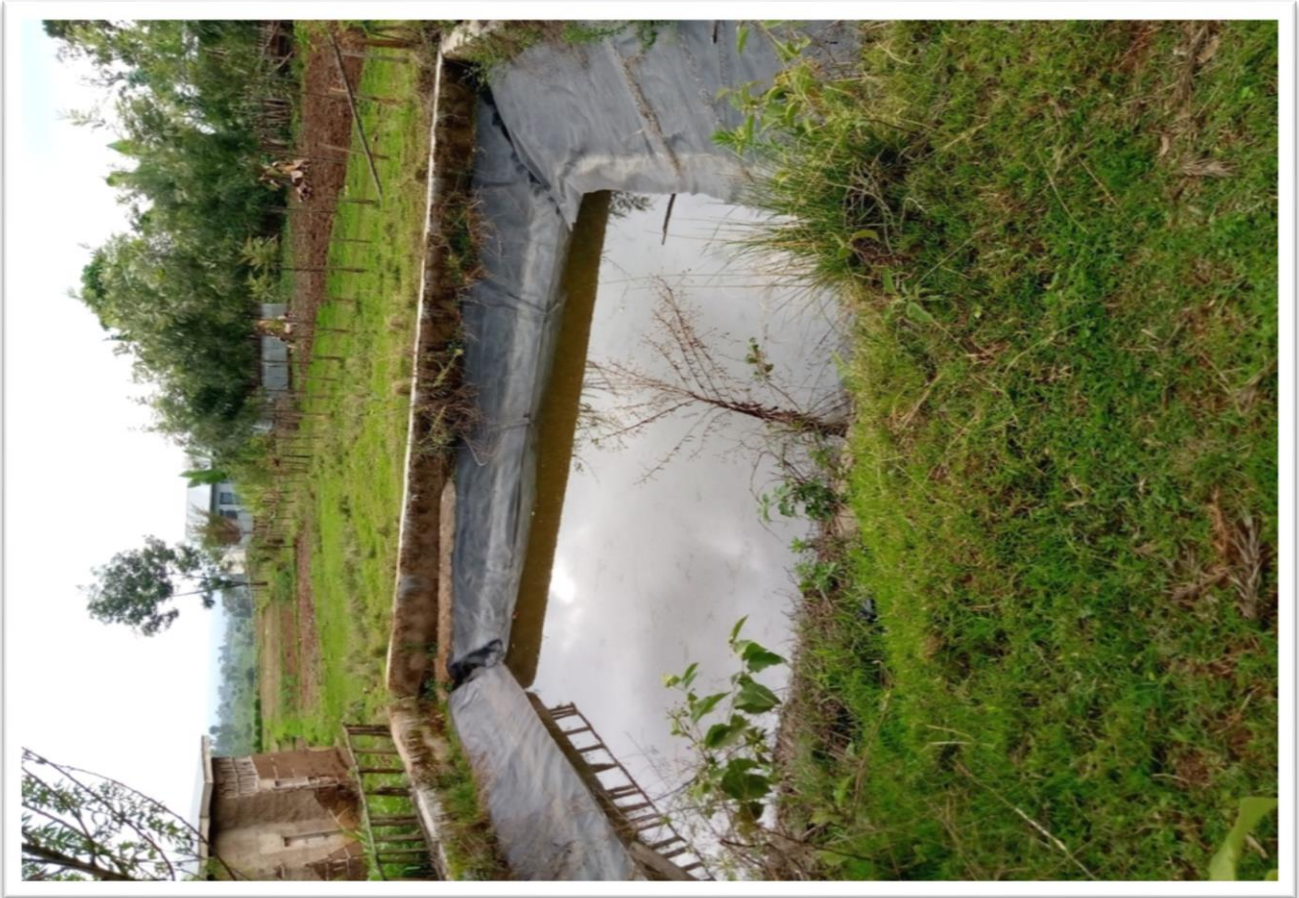


Source: Own plot survey, 2021

Figure4.Gorche woreda farm plot implement Hillside terrace

4.5.4. Rainwater Harvesting: It is the accumulation and deposition of rainwater for reuse before it reaches the aquifer. Uses include water for garden, water for livestock, water for irrigation, and indoor heating for houses and for other purposes. As adoption alternative to address the impacts of soil erosion in the study area, use of available rainwater through different harvesting techniques including flood water diversion, on farm runoff retention, soil moisture conservation and impounding in storage structures were implemented by the Woreda Office of Agriculture for last five years. This option focuses on harvesting and utilizing as much rainwater as possible and making maximum use of it to increase production and productivity of the land (Table 15). Even

if rainwater harvesting for growing crops is another possible option to compromise scarcity of water that associated with iritic rainfall, only 10% of respondents practiced rainwater harvesting to control the problem



Source: Own plot survey, 2021

Figure.5. Water harvesting structures implemented at farm plot

Table 10 Distribution of improved soil and water conservation measures in the study area (at 139 house hold farmer’s plot of land)

Variables Responses whether farmers practiced (SWCPs) or not			
Types of SWCPs	Count		ISWCP of count farmers implement
		%	
Soil bund	105	28	75
Cut-off drain	127	34	91
Hillside terrace	86	23	16
Rainwater harvesting	55	14	10
Total	373	100	192

Source: Survey result (2021)

4.6. Farmers’ Perception towards Physical SWC Practices

4.6.1. Farmers’ perceptions on adoption of physical SWC practices

Farmers asked and responded about their perception on improved soil and water conservation practices was measured by summing up the reaction of positive, negative and neutral response to a list of questions to achieve this, a five point Likert scale containing items with response categories ranging: strongly agree, Agree, no opinion, disagree and strongly disagree for developed questions. Farmers were asked to articulate their perception towards whether improved soil bund increases the quality of soil fertility or not. Accordingly, about 24% respondents expressed their disagreement assuming that using fertilizer, composite, and other indigenous conservation measures are vital than using soil bund. For other item which says “improved hillside terraces need more use of inputs”, about 40% of sample households agreed.

Table 11 Farmers' perceptions on adoption of SWC practices (5-point Likert type scale measure)

Items(1)	Responses									
	Strongly agree		agree		No opinion		Disagree		Strongly disagree(5)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1.Improved soil bund increases the quality of soil fertility	32	23	46	33	20	14	34	24	75	53
2.Improved soil bunds are Possible to practice on small farm plots	64	46	14	10	24	17	27	19	10	7
3.Special rainwater harvesting that is available for farmers	36	26	54	39	21	15	18	13	10	7
4.Hill side terraces need more use of inputs	69	50	56	40	6	4	3	2	5	4
5.Improved soil bund and Cut-off drain require frequent maintenance	47	34	58	42	22	16	8	6	4	3

Source: Own survey, 2021

4.6.2. Perception of farmers on erosion as a problem

Perception of farmers on soil erosion as a problem to soil productivity and sustainable agriculture is the most important determinant in the adoption of soil and water conservation practices. Theoretically, those farmers who perceive soil erosion as a problem, having negative impacts on productivity and expect positive returns from conservation, are likely to decide in favor of adopting available conservation technologies. On the other hand, when farmers do not accept soil erosion as a problem, they cannot expect benefits from controlling the erosion process and they

will be by side against adopting any conservation technologies (Gebremedhin and Swinton, 2003; Gebeyanesh and Terefe, 2017).

As a result in Table17, 66.2% responded that soil erosion is a serious problem on their farm land while 33.8% have not. From this result, 69.28% of adopters and 62.3% of non-adopters responded that soil erosion is a serious problem on their own farm land. The rest 30.76% and 37.7% adopters and non- adopters respectively stated that soil erosion has not serious problem. The Chi-square test result indicated that there was statistically significant relationship between adopters and non-adopters of soil and water conservation practices and perception of soil erosion as a problem($X^2= 14.568$, $p=0.000$, $DF=1$).

The household head were also asked their perception about soil erosion can be controlled. From the adopters 70.5% perceived that soil erosion could be controlled, while 29.5% responded that soil erosion could not be controlled. However, 54.1% of non-adopters of the respondent answered that soil erosion could be controlled, while 45.9% respondents believed that soil erosion could not controlled totally, but believed that it could be possible to decrease some degree of its severity.

Table 12: Farmers’ perceptions on soil erosion

Description		Frequency		Adopters		Non-adopters		DF	Chi-square	
		N	%	N	%	N	%		X ²	p-value
Is soil erosion	Yes	92	66.2	54	69.2	38	62.3			
a serious problem	No	47	33.8	24	30.8	23	37.7	1	14.6	0.000
in your farm land	Total	139	100	78	100	61	100			
Is soil erosion	Yes	88	63.3	55	70.5	33	54.1			
Can be controlled	No	51	36.7	23	29.5	28	45.9	1	9.8	0.002

Source: Own Survey, 2019 Significant at 1% and 5% significant level

4.6.3. Farmers’ response on causes of soil erosion

Soil erosion is caused by different factors. Farmers also forward various causes of soil erosion in their farm land and surrounding landscapes. As presented in Table 17, farmers were asked for the major causes of soil erosion in the study area. The 39.6% of the respondents responded that deforestation was the major causes of soil erosion followed by over cultivation (25.2%); high rainfall (14.4%); absence of conservation practices (13.7%); cultivation of hill side (5.8%) and over grazing (1.4%). The participants of focus groups key informant also confirmed that the major causes of soil erosion in the study area were deforestation, over cultivation without fallowing, high rain fall, absence of conservation practice, cultivation of hill side (slope land) and overgrazing were mentioned as major problem. In generally, almost all respondents have a good knowledge about the causes of soil erosion problem.

Table 13: Ranks of farmers’ response on causes of soil erosion and risks

Causes of soil erosion	1 st	2 nd	3 rd	4 th	5 th	6 th
Cultivation of hill side(slope land)	8	68	17	20	13	13
Absence of conservation practices	19	15	39	30	18	18
Overgrazing	2	2	28	33	39	35
Over cultivation	35	39	21	12	15	17
High rainfall	20	12	22	27	29	29
deforestation	55	3	11	18	26	26

Source: Own Survey, 2019

4.7. Factors Affecting Farmers’ Perception on Adoption of Physical SWC Practices

The binary logistic regression model was used to identify the influencing factors of adoption of soil and water conservation practices and to assess their relative importance in determining the probability of being an adopter of soil and water conservation technologies. The dependent variable was dummy, which takes a value of zero and one depending on whether or not a farmer is adopter or non-adopter of improved soil and water conservation practices. Model diagnostics were performed to check for possible model specification errors for both continuous and dummy independent variables. Tests showed that the model was free from omitted variables and multi-collinearity, so it was appropriately fit for data.

As can be seen from the binary logistic regression results, out of the twelve hypothesized variables, six variables such as education, extension service, farmland distance from homestead, slope of land, off-farm activity and perception were found to affect the adoption of soil and water conservation technologies. From above variables education, access to extension service, slope of

land and perception was significantly and positively affect the adoption of improved SWC technologies while farm land distance and off-farm activities was significantly and negatively affect adoption of improved SWC technologies. But age, sex, family labor, Tropical Livestock Unit (TLU), access to credit and total farm land holding had insignificant relation to the adoption of soil and water conservation practices. In table: 19, the results of model and statistically significant variables were discussed below.

Table14: Binary logit model results for the factors affecting adoption of SWC practices

variables	B	S.E	Wald	df	Sig.	Exp(B)
Age	0.004	0.024	0.026	1	0.872	1.004
Sex	0.938	0.643	2.126	1	0.145	2.555
Educ.	1.032	0.525	3.855	1	0.050**	2.806
Familylabor	0.155	0.279	0.310	1	0.578	1.168
Ext.service	1.181	0.527	5.020	1	0.025**	0.307
TLU	-0.034	0.072	0.226	1	0.635	0.966
Acc.credit	0.531	0.665	0.638	1	0.425	1.700
Far.dist.	-2.007	0.465	18.627	1	0.000*	7.444
Slope	0.817	0.306	7.136	1	0.008*	0.442
Off-farm	-1.05	0.612	9.691	1	0.002*	0.149
HHland h.	-0.598	0.500	1.431	1	0.232	0.550
Percep.	1.173	0.512	5.241	1	0.022**	3.231
Const.	-3.158	2.628	1.444	1	0.229	0.043
Number of obs. = 139, $R^2 = 53.8\%$, $-2\text{Log likelihood} = 119.233$, $\text{LR Ch}^2 = 17.086$						

Source: Own survey, 2021*1%, **5% and ***10% significant levels

4.7.1. Educational status of household heads

Education is generally believed to be important to complement indigenous knowledge and to enhance the ability of farmers to process new information. As expected, education level of household head was positively related to the adoption of improved soil and water conservation

practices and significant at 5% level. The odds ratio or Exp (B) of 2.806 for education implies that keeping the influence of other factor constant, the decision to adopt improved soil and water conservation practices are increasing by a factor of 2.806 as the households' education level increase. This further implies that education provides capacity to analyze related information on conservation measures which in turn results in a greater adoption of improved soil and water conservation technologies. The finding of Debebe and Tesfaye (2013) and Terefe (2017) supported this study result where by indicated a positive association between literacy and adoption of soil and water conservation practices.

4.7.2. Access to extension service

The major component that facilitates the adoption of SWC measures are extensional agents by providing accurate and reliable information to farmers. The close contact with extension agents have great role on agricultural output. Thus, access to extension services had a positive significance at 5% level of significance [B=1.181, P=0.025] which is analogous to the hypothesis. The odd ratio result depicts that those farmers who have access to extension service are 0.307 times greater than those who do not have contact with extension service to adopt SWC structures.

The finding was similar with the study of Desta (2012), Simon *et al.* (2012) Tesfaye *et al.*, (2013) and Solomon (2015) state that extension services have a positive effect on ISWC practices. Benin (2002) also indicates that access to extension agents related with the use of more fences and stone terraces refers that farmers built for long term land improving techniques.

4.6.3. Farm land distance from homestead area

One of the major physical factors that determine the adoption of SWC practices was distance between residence and farm land areas of household head. Regarding to the distance of farmland

from the residence of farmers, there was statistically negative significant with the adoption of SWC practices [B= -2.007, P= 0.000]. This indicated that farm plot distance from the residence discouraged farmers to adopt improved soil and water conservation technologies.

This result is supported by the finding of Kessler (2006). He suggests that farmers invest more in SWC activities suited near to their residence. Fikru (2009) also suggests that longer distance between residence and their farm land is positively significant with the adoption of ISWC structures. The scattered and far away field is one of the factors that discourage farmers.

4.7.4. Slope of farm land

As hypothesized, the variable slope of land took the hypothesized positive sign and significant. This indicates that slope of land influences adoption of soil and water conservation technologies positively. This is because slope is an indicator of soil and water loss from the farm land. This implies that farmers cultivating vulnerable fields are more likely to adopt ISWC technologies in their farms than those cultivating less vulnerable fields. The odd ratio result also indicated that slope land increases the adoption of ISWC by the factor of 0.442 times controlling other variable constant.

4.7.5. Off-farm activities

The major sources of income for sample households were farming. But some farmers participate in off –farm activities to get additional income to support their life. The binary logistic regression analysis indicates that off-farm activities are negative and significant relationship at 1% level of significant [B=-1.905, P=0.002]. The odd ratio result also suggests that participating in off-farm activities reduces the rate of adoption of physical SWC practices by the factor of 0.550.

Derajew (2013) stated that income generated from off-farm activities would be used to hire labor for soil conservation. The negative relation between farmers' decision to construct conservation structures and proportion of off-farm activities were also supported by the finding of Bekele and Holden (1998). They approve that the participation of household members in off-farm activities have a great effect on the decision behavior of farmers in the adoption of physical soil and water conservation practices. As a result, farmers who were participating in off-farm activities were likely to put less effort in retain conservation practices.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Soil is the most important resource for the existence of human beings. But soil degradation is a prominent agricultural and environmental problem that human beings are facing in today's world. Without adoption of physical SWC practices becomes a challenge of food security by minimizing the ability to improve agricultural production and productivity in the study area. At the face of increased dependency on the agricultural sector for economic development, sustained use the land resource has become very important. In order to solve erosion problem and enhance the production potential of agricultural land, different types of physical SWC practices and approaches were introduced by governmental and non-governmental institutions. However, the efforts implemented towards the practices of the newly adopted technologies so far seem to have limited impact in increasing the sustained use of physical SWC practices.

The principal objective of this study was to assess farmers' perception on adoption of physical soil and water conservation practices at farm level in Gorche Woreda. Accordingly, this study analyzed the socio-demographic, economic, physical and institutional factors; farmers' perception of erosion as a problem and factors affecting adoption of soil and water conservation measures in the area.

Descriptive statistics was used to explain the socio-demographic, economic, physical and institutional factors of the sampled households. The chi-square and t-test results showed that out of hypothesized variables socio-demographic (age, sex, family labor and education), economic

(farm land holding, and off-farm income), physical (slope of land and farm distance from homestead area) and institutional factors (access to extension service and credit) were found significant while livestock holding was found insignificant.

Farmers perceived that soil erosion problem has considerable effect in improving the farming households managed farm and their livelihoods. They have also perceived that causes of soil erosion are related to ideal management of deforestation, overgrazing, cultivation of hillside slopes and as well as over cultivation related problems.

The finding of binary logit regression model revealed that educational status, access to extension services, slope of land and farmers' perception were positively and significantly affected the adoption of soil and water conservation practices. While farm land distance and off-farm activities were negatively and significantly influenced farmers' decision to adopt soil and water conservation practices in the study area.

5.2. Recommendations

Based on the results, discussion and findings of the study, the following recommendation points were presented as follows.

Education status of household head is one of the influential factors for the adoption of improved soil and water conservation practices. So it is important for farmers to get at least basic education through adult education program, workshops and training should focus on scientific and technical practice as well as the importance of physical soil and water conservation practices.

One of the influential factors for the adoption of physical SWC practices is extension services. Therefore, the extension agents should regularly contact with farmers as much as possible. It is also advisable that extension agents should live within the farming community they are serving. Slope of land is one of the influential factors for the adoption of physical SWC technologies. Therefore, slope land should be managed carefully and properly. Farmers should use biological or agronomic conservation practices (contour cultivation, tree planting to improve soil fertility, conserve soil moisture and then to reduce runoff).

Participation in off-farm activities is the significant factor that influences farmers' adoption to retain conservation structures negatively. This is due to the fact that farmers who are involved in off-farm activities lack the required resources (mainly labor and time) to maintain and retain conservation structures. Such farmers need to be supported so that they can make decision to invest on conservation measures. Furthermore, the agricultural sector has to be made more attractive so that farmers can invest more on conservation based agriculture. This requires making the sector more productive by introducing improved technology (more productive and affordable), and providing required infrastructure for development of market such that farmers

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

Distance of farmlands from residence is significant factors that negatively influence farmers' practice of physical SWC measures at farm plot level. Farmers who are involved in farm lands located far from their homestead face the constraint of time and labor to maintain physical SWC practices. Therefore, farmers have to find to such problem in the adoption of physical SWC measures.

This study is just a step to pave a way for further study, presenting the above recommendations for more research to validate and expand the result of this study. So, this findings help as the supportive documents for the other researchers who undertake further studies on this area. The further research could include: forest protection, traditional practices, causes and consequences of land degradation.

REFERENCE

- Abera,2003. Factors Influencing the Adoption of Soil and Water Conservation Practices in North Western Ethiopia. Discussion Paper No. 37, University of Gottingen, Gottingen.
- Brihanu,2014. Environmental degradation and management in Ethiopian Highland Review of lessons learned. International Journal of Environmental Protection Policy, 2(1), 24-34..
- Akililu amsalu & Jane de, 2006 .Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian Highland watershed;
- Awdenegest M. A., 2006 . Farmers' Perceptions of Soil Erosion and Soil Fertility Loss in Southern Ethiopia: Journal of Land degradation and Development18:543–554.
- Bekele, 1998. Peasant Agriculture and Sustainable Land Use in Ethiopia. Economic Analysis of Constraints and Incentives for Soil Conservation. Unpublished Doctoral Dissertation. Agricultural University of Norway.
- Bekele S. a., 1998.“Resource Degradation and Adoption of land Conservation Technologies in the Ethiopian Highlands”. A case study in AnditTid,North. The Journal of the International Association of Agricultural Economists, 18(18), 233-247.
- Bekele S. a., 1998“Soil and Water Conservation Decision Behavior of Subsistence Farmers in the Eastern Highlands of Ethiopia: A Case Study of the HundeLafto Area. Journal of Ecological Economics, 46: 61-81.
- Bekele S., 1998. Peasant Agriculture and Sustainable Land Use in Ethiopia.Economic Analysis of Constraints and Incentives for Soil Conservation Unpublished Doctoral

- Bewket Tadesse, 2009. Farmers' Participation in Soil and Water conservation activities in Chemoga Watershed, Blue Nile Basin, Ethiopia. *Land Degradation and Development. Journal of Agricultural Economics*. 13:189-200.
- Brihan Asmame, 2014. Farmers' perception and adoption of soil and water conservation Measures in GidanWorada, North Wollo, Ethiopia *Journals of economics and Sustainable development* ISSN 2222-1700 (paper) ISSN 2222-2855 (online). Vol. www.iiste.org
- Bunch, 2011. African's soil fertility crisis and the coming famine. In *state of the World 2011. Innovations that nourish the planet*. New York: W.W. Norton & Company.
- Catherine Bowyer et al, 2009. *Land Degradation and Desertification*. Brussels
- Cramb A., 1999. Smallholder adoption of soil conservation technology: evidence from upland projects in the Philippines *Land degradation and development*. 10:405-42.
- De-Graaff, 2008. *Factors Influencing Adoption and Continued Use of Long-term Soil and Water Conservation Measures in Five Developing Countries*. Applied Geography, Inc. Press.
- Drake, 2003. "Soil and Water Conservation Decision Behavior of Subsistence Farmers in the Eastern Highlands of Ethiopia: A Case Study of the Hunde-Lafto Area" *Journal of Ecological Economics*, 46: 61-81.
- EleniTesfaye, 2008. *Continued Use of Soil and Water Conservation Practices: a Case study in Tulla District, Ethiopia*, Erosion and Soil & Water Conservation Group, Wageningen University, Wageningenur.
- Erkossa, 2015. Linking soil erosion to on-site financial cost: Lessons from watersheds in the Blue Nile basin *Solid Earth*, 6(2), 765-774. DOI: 10.5194/se-6-765.
- Eshetu, 2014 'Forest resource management systems in Ethiopia: historical perspective', *International Journal of Biodiversity and conservation*, vol. 6, No. 2, pp. 121-131
- Farmers land use policy 24 (2007) 404-416.
- FAO (1986). *Ethiopian Highlands Reclamation Study, Ethiopia Final Report*, FAO Rome.
- FAO (1987). *Incentives for community Involvement in Conservation programs*. No.12, Rome.
- FAO, (2010) a. *Save and Grow: A policy-Maker's Guide to the Sustainable Intensification of*

Small holder Crop production. Rome.

FDRE, 2015. Report (Federal Democratic Republic of Ethiopia). Ethiopia –land degradation Neutrality National report. The LDN project, UNCCD Research Center of the European Commission and CAP 2100 International. 45pp.

Fekadu Beyene, Yenealem Kassa, Jema Haji, and Belaineh Legesse, 2013. Impact of Integrated Soil and Water Conservation Program on Crop Production and Income in West Harerghe Zone, Ethiopia. *International Journal of Environmental Monitoring and Analysis*. Retrieved on 6, May 2014 from Vol.1.No.4,2013,pp.111-120.dio:10.11648/j.ijema.20130104.11

Fikru, A. 2009. Assessment of Adoption Behavior of Soil and Water Conservation Practices in The Koga Watershed, Highlands of Ethiopia. Unpublished Master Thesis, Cornell University, School of Graduate Studies, New York. (Country Not Stated).

Gebremedhin Birhanu and Swinton S.M 2003. Investments in Soil Conservation in Northern Ethiopia: The Role of Land Tenure Security and Public Agricultural Economics, 29: 69-94. Graaff JD. (1993). *Soil Conservation and Sustainable land use: An Economic Approach* Royal Tropical institute.

Gould, B.W., Saupe, W.E., Klemme, R.M. 1989. Conservation Tillage: "The Role of operator Characteristics and perception of soil Erosion". *Land Economics* 65, 167-182.

Gujarati, 1995. *Basic Econometrics*, 3rd edition, McGraw-Hill, Inc: New York. 838p.

Gujarati D. 2004, *Basic Econometrics*, 4th edition, McGraw-Hill, Inc: New York. 82p.

Habtam E. (2006). Adoption of Physical Soil and Water Conservation Structures in Anna Watershed, Hadiya Zone: Unpublished Master Thesis, Addis Ababa University, School Of Graduate Studies, Addis Ababa

Hailu Birara (2011). Factors influencing the adoption of soil and water conservation practices: A Case Study in Debarq Worada, North Gondar Zone, Ethiopia.

Holden, S.T., Shiferaw, B., Wik, M. 1998. "Poverty, market Imperfections and Time preference

- Of Relevance for Environmental policy". *Environmental and Development Economics* 3,105-130.
- Hurni, H.(1996). *Precious Earth: From soil and water conservation to sustainable land Management*. International soil conservation organization and center for Development And Environment; University of Bern.
- Hurni, H., (2009). *World Soil Erosion and Conservation*. In Pimental, D. (eds) Cambridge University Press, New York, USA.
- Hurn H. (2015). *Soil degradation and sustainable land management in the rained Agricultural areas of Ethiopia: An assessment of the economic implications*. Report for The economics of land degradation initiative. Bonn, Germany: ELD initiative.93pp.
- IJEMA (*International Journal of Environmental Monitoring and Analysis*), (2013),1(4):1-2Published online August 20, 2013.
- Jones, A. et al., 2013. *Soil Atlas of Africa*. Luxembourg: Publications Office of the European Union.
- j.graff, 2006. *Farmers views of soil erosion problems and their Conservation knowledge at Beressa Watershed, Central Highland of Ethiopia*
- Kessler, A. 2006. *Moving People-Towards Collective Action in Soil and Water Conservation's Experiences from the Bolivian Mountain Valleys*. Unpublished Doctoral Dissertation, Wageningen University.
- Kibemo, 2011. *Farmers' Perception on Soil Erosion and Their Use of Structural Soil Conservation Measures in Soro District, Southern Ethiopia*. Master's Thesis, School of Graduate Studies, Addis Ababa University, Addis Ababa.
- Mekonnen, 2011. *Maejo International Journal of Science and Technology: Impact Assessment of Soil and Water Conservation Measures at Madego Watershed in Tigray, Northen Ethiopia*. 5(03), 312-330.

- Kirui, O. K. and Mirzabaev, A., (2014). Economics of land degradation in eastern Africa, s.l.: Department of Political and Cultural Change Center for Development Re University of Bonn.
- Krishna, R., Bicol, K., Ingrid, I. and Giridhari, S. (2008). Determinants of Farmers Adoption of Improved Soil Conservation Technology in a Middle Mountain Watershed of Central Nepal. Environmental Management, Springer, New York.
- Kruger, H., Berhanu, F. Hans-Joachim *et al*, Gebremichael, Y., and Kejela, K. (1996). Creating an Inventory of Indigenous SWC Measures in Ethiopia. In Sustaining the Soil: Indigenous Soil and Water Conservation in Africa, (ed.) I.S.C. Reij, Princeton Co., London.
- Lakew Desta et al., 2005 (eds). Community Based Participatory Watershed Development: A Guidline. Addis Ababa: Ministry of Agriculture and Rural Development.
- LakewDesta, MenaleKassie, S. Benin and J.Pender, (2006). Land degradation and strategy for Sustainable development in the Ethiopian highlands: Amhara Region Bahir Dar. Ethiopia Social-economics and Policy Research Working Paper 32
- Lavison, 2013, Factors influencing the adoption of organic fertilizers in vegetable Production in Accra, M.Sc. Thesis, Accra Ghana.
- Loevinsohn M, Sumberg J, Diagne A (2012). Under what circumstances and conditions does adoption of technology result in increased agricultural productivity? Protocol London: EPPI Centre, Social Science Research Unit, Institute of Education, university of London.
- Lynne GD., Shonkwiler JS and Rola LR.(1988). “Attitudes and farmer conservation Behaviour” American Journal of Agricultural Economics.70 (1): 12–19.
- GWANRO), 2021. Annual Report Presented for Evaluation and Discussion.
- GWCO, 2021, Annual Report.
- Mazengia Shimelis, 2010. Conservations of natural resources for sustainable development: in CaseofDegem district of North Shewa Zone, Oromia Regional State, and thesis for

- MA, AAU, Ethiopia.
- Mekuria Argaw, 2005. Forest conversion - soil degradation - farmers' perception nexus: Implications for sustainable land use in the southwest of Ethiopia. Ecology and Development Series No. 26, 2005, CuvillierVerlag Gottingen
- Menale, K., Pender, J., Yesuf, M., Kohlin, G. & Elias, M. (2008). The Role of Soil Conservation On Mean Crop Yield and Variance of Yield. Discussion Paper No EfD Dp.08-08 March 2008.
- Mesfin Nigusse, 2015. Adoption of physical soil and water conservation structures: MSc thesis Case of Wonago Woreda, SNNPR, Ethiopia.
- MoARD) 2007. Thematic paper on land Degradation and Poverty: MOARD with WB publication. Addis Abab.
- MoFED, 2006. Ethiopia: building on progressa Plan for Accelerated and Sustained Development and Poverty (PASDE (2005/06- 2009/10); Volume 1: Main Text. Addis Ababa, Ethiopia. Pp. 85-to E190.
- Mitiku Haile, Karl Herweg, and Brigitta Stillhardt, 2006. Sustainable Land Management – A new approach to Soil and Water Conservation in Ethiopia. Mekelle, Ethiopia: Land resources Management and Environmental Protection Department, Mekelle University.
- Mulugeta, 2010. Assessment of Integrated Soil and Water Conservation Measures on Key soil Properties in South Gonder, North-Western Highlands of Ethiopia. Journal of Soil Science and Environmental Management, 1(7):164-176.
- Research Council (NRC 2007) Emerging technologies to benefit farmers in sub-Sahara Africa and south Asia. Washington, DC: National Academy of Sciences.(NMA), National Meteorology Agency (2019) Annual report.
- Nknya, E.; Joachim Von Braun, J.; Mirzabaev, A.; Bao Le, Q.; Young K, H.; Kirui, O., 2013.

ELD Initiative: Methods and approach for global and national assessments. ZEF

Discussion papers on development policy no. 183, university of Bonn, Germany.

Noble, A. 2012. The slumbering Giant: land and degradation. Canberra, Australia: Crawford Fund Proceedings.

Pimentel, D. 2006. Soil Erosion: a Food and Environmental Threat; Journal of Environment, Development and Sustainability, 8: 119–137.

Robert Kaliisa 2012. Determinants of Soil Water Conservation and Nutrient Flow Management in Bufundi Sub- Catchment, Kabale District, Uganda

Selamawit Yared, 2017. Soil fertility management practices employed by farmers in Malga Woreda, Sidama Zone, Southern Ethiopia. An Unpublished MSc. Thesis Hawassa University Ethiopia.

Solomon Birhanu, 2016. Assessment of factors determine farmers' adoption behavior of soil and Water Conservation practices Libo Kemkem Woreda. MSc. Thesis, college of social Sciences Department of geography and environmental studies, Addis Ababa University.

Shiferaw Bahilu and S. Holden, 2008. "Resource Degradation and Adoption of Land

Conservation Technologies in the Ethiopian High Lands: A case study in Anditid, North Shewa", Agricultural Economics, vol. 18, 3, PP.233-247.

SUSTAINET EA 2010. Technical Manual for farmers and Field Extension Service Providers:

Soil Water conservation. Sustainable Agricultural Information Initiative, Nairobi. ISBN 978-9966-1533-8-8.

Taffa Tulu, 2002. Soil and water conservation for sustainable agriculture pubs. Addis Ababa, Ethiopia.

Tato.K.(1990). Ethiopian Experience Including policy: Ethiopian Soil Conservation Programme

and its Future Trends. A Paper presented at the conference on conservation strategy for Ethiopia, 22-25 may, 1990 Addis Ababa

- Tekalegni Negash, (2011). Farmers' perception on the role of vetiver grass in soil and water Conservation in south western Ethiopia: - The case of Tulube Peasant Association; Metu District. 2011.
- Terefe K., 2017. Assessment of Farmers' Adoption Status of Improved Soil Water Conservation Practices : The Case of Zala District GamoGofa Zone, Southern Ethiopia. An Unpublished MSc. Thesis Hawassa University Ethiopia.
- Tesfaye A, Deneke TT, Selassie YG. 2012a. determinants of maintenance decision of introduced Soil and water conservation practices in Fagita Lekoma district, northwest highlands of Ethiopia Journal of applied sciences & technology 5:1-17.
- Taffa Tulu, 2002. Assessing the role of traditional land management practices in Improving cropland productivity: the case of Diga Woreda, Oromia Ethiopia.
- UNCCD, and CFC, (2009). African dry lands commodity Atlas, s. l. secretariat of the United Nations Convention to Combat Desertification and the common fund for the Commodities in cooperation with Intergovernmental Groups on Grains of the FAO, and International crops research institute for the semi-arid tropics.
- UNCCD, 2013. Background document: the economics of desertification, land degradation and Drought: methodologies and analysis for decision making. Bonn, Germany, United Nations Convention to Combat Desertification.
- UNCCD, (United Nations Convention to Combat Desertification) 2014. Land degradation Neutrality: resilience at local, national and regional levels.
- Upton M., 2012. Is Africa different? Economics of the livestock sector, Galv Med Abstracts. Available at; <http://www.galvmed.org/wp-content/uploads/2013/07/Abstract-Paper-1-Upton-Final-18June13.pdf>. (Last accessed March 16th 2015).
- USAID, 2008. Ethiopia biodiversity and tropical forests 118/119 assessment retrieved November,2014, from http://pdf.usaid.gov/pdf_docs/PNADM939.pdf.
- Wogayehu, B. and Drake, L. 2003. Adoption of Soil and Water Conservation Measures by the Subsistence Farmers in the Eastern Ethiopia: Presented at the 17 World Congress of Soil Science. Held in Bangkok, Thailand, June 15-18.

- Wogayehu, B. & Darke, L. 2003. Soil and Water Conservation Decision of Subsistence Farmers in the Eastern Highlands of Ethiopia: A Case Study of the Hunde-Lafto.
- Wogayehu Gashaw, 2006. Determinants of Farmers Decision on Soil and Water Conservation Practices in Dire Dawa Administration. Unpublished master's thesis, Alemaya University, Ethiopia.
- WOCAT, (World Overview of Conservation Approaches and Technologies), 2007. Where the Land greener-case studies and analysis of soil and water conservation initiatives Worldwide. Editors: Hanspeter Liniger and William Crichley.
- Wolka Kebede, 2014. Effects of soil and water conservation measures and challenges for its Adoption: Ethiopia in focus, journal of environmental science and technology, 7(4), 185- 199. World Bank, 2012c. The little green data Book-Ethiopia.
- World Bank, 2006. Sustainable land management: challenges, opportunities and trade-offs. The International Bank for Reconstruction and Development. Washington, DC. 112p.
- World Bank, 2008. Sustainable land management and source book: agriculture and rural Development, World Bank, Washington DC.
- Woldeamlak B. 2003. Towards Integrated Watershed Management in Highland Ethiopia: The Chemoga Watershed Case Study. Doctoral Dissertation Wageningen University, Wageningen.
- Yamane Taro, 1967. Statistics: An Introductory Analysis, 2nd Ed., New York: Harper and Row.
- Yihene G. Selassie and Tilahun Amede 2014. Investing in land and water management Practices in the Ethiopian Highlands: Short- or long-term benefits? Bernard Vanlau we, piet Van Asten, Guy Blomme (eds), challenges and opportunities for agricultural Intensification of the humid highland systems of sub-saharan Africa, 2014. New York, London. DOI 10.1007/978-3-319-07662-1_9.
- Yisehak Kechero; Belay, D.; Taye, T.; Jansen, G. 2013. Impact of the soil erosion associated Factors on available feed resources for free-ranging cattle at three attitude regions: Measurements and perceptions. Journal of arid environments, 98, 70-78.
- Zemenfes Tsighe (1995). The Political Economy of Land Degradation in Ethiopia. Journal of Northeast Africa Studies 2(2): 71-98.

APPENEX

Appendix 1: Conversion factors used to compute man equivalent (labor force)

Age categories	Man equivalent	
	Male	Female
<10	0.00	0.00
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1.0	0.8
>50	0.7	0.5

Source: Storck et al., 1991

Appendix 2: Conversion factors used to compute TLU

Types of animals	Conversion factors
Calf	0.25
Heifer	0.75
Ox/Bull	1.0
Donkey	0.75
Camel	1.25
Sheep and Goat	0.13
Chicken	0.013

Source: Storck et al., 1991

Appendix 3: VIF of the continuous independent variables

Variables	Collinearity Statistics	
	Tolerance	VIF
Age of HH in years	0.830	1.204
Family labor	0.834	1.199
Tropical livestock unit	0.905	1.105
Total farm land size in hectare	0.902	1.108

Appendix 4: Contingency coefficient of dummy and categorical independent variables

Variables	Sex	Education	Ext.service	Acc.to credit	Off-fa.	Slope	Farmland dis.
Sex	1						
Education	.706	1					
Ext.service	.330	.391	1				
Acc.to credit	.041	.375	.5321	1			
Off-farm	.156057	.732	.172		1		
Slope	.364	.388	.433	.000	.000	1	
Farm distance	.555	.150	.110	.000	.245	.000	1

HAWASSA UNIVERSITY

HAWASSA, ETHIOPIA

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF SCIENCE IN
SOIL AND WATER CONSERVATION ENGINEERING**

The principal objective of this Questionnaire is to assess the adoption of improved soil and water conservation technologies at farm plot level by farmers in reference to some selected kebeles of Gorche Woreda. All questions to be asked are purely for academic purpose. As a result, I kindly ask you to share me your opinion and experiences, taking few minutes from your schedule of time.

Thank you in advance for your cooperation!

General Information of the Respondents

Questionnaire Code: _____ Date: _____

Region: _____ Zone: _____

Worada: _____ Kebele: _____

I. Household Demographic Characteristics

1. Age of household head _____

2. Sex of household head 1, Male 2, Female

3. Educational level of household heads?

1, Unable to read & write 2, Able to read & write

- 3, Completed primary education 4, Completed secondary education
 5, Certificate and above

4. Marital status of the respondents

- 1, Married 2, Divorced 3, Widowed 4, Single

5. Number of household size 1, Male _____ 2, Female _____ 3, Total _____

6. Number of household labor _____

7. Did you Productive Safety Net Program beneficiary? 1, Yes 2, No

8. What type of Crops you produce? 1, _____ 2, _____ 3, _____

9. What is the share of your land type and livestock size?

No	Types of land use	Area in Hectare	Livestock size		
			No	Types	Size
1	Home stead area		1	Ox	
2	Cultivated land		2	Cow	
3	Grazing land		3	Goat	
4	Fallow land		4	Sheep	
5	Forest land		5	Young bull	
6	Others		6	Heifer	
Total			7	Donkey	
			Others		

10. Do you have your own agricultural land?

- 1, Yes 2, No

11. If your response is Yes for Q (10), what is the size of landholding of the household in hectare? A, < 0.25 B, 0.26-0.5 C, 0.6-1 D, 1.1-1.5 E, > 1.5

12. How many parcel/s of land have you cultivated?

1, One 2, Two 3, Three 4, More than three

13. How did you get access to land? (Multiple responses are possible)

1, through land redistribution 2, Shared with relatives
3, Inherited from parents 4, Others (Specify)_____

II. Farmers Perception about soil water conservation technologies

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

1, near 2, Far 3, very far

2. On average what is the distance of your cultivation fields from your home? _____ Hours

3. How do you perceive the fertility of most of your farm land?

1, Very high 2, High 3, Medium 4, Low 5, Very low

4. What type of farm land is more productive?

1, flat to very gently sloping 2, gently sloping 3, sloping to strongly sloping
4, moderately sloping 5, steep to very steep sloping

5. How do you see the productivity of your farmlands?

1, increasing over time 2, decreasing over time 3, almost the same 4, do not know

5.1. If the yields of most of your farmlands decreasing, what could be the reason behind?

(Multiple response)

- 1, Absence of fallowing 2, Erosion 3, Absence of chemical fertilizers
4, Over cultivation 5, Erratic rainfall 6, others, specify_____

5.2. If your response is decreasing for Q. number 4, what measures are you taking to improve your production?

- 1, Using SWC measures 2, Using manure 3, Using fertilizers
4, Crop rotation 5, All 6, others, specify_____

6. How do you see the size of your agricultural land over time?

- 1, Almost the same 2, Decreasing 3, Increasing 4, Do not know 5, Others, specify_____

6.1. If the agricultural land size is decreasing, what could be the reasons behind?

- 1, Population pressure 2, Land degradation 3, Taken by government
4, Taken by other organization 5, Expansion of forest 6, Others, specify_____

6.2. If the agricultural land size increasing, what could be the reasons behind?

- 1, Expansion to the marginal land 2, Expansion to the forested area through deforestation
3, Gift from relatives or parents 4, If others specify_____

7. Do you believe that there is soil erosion problem in your farm land? 1, Yes 2, No

8. Do you believe that the causes of soil erosion can be controlled? 1, Yes 2, No

9. How do you compare the problem of land degradation in your farm land after conservation?

Structures were built?

1, Aggravated 2, Reduced 3. No change 4, I do not know

10. What condition brings soil erosion in your land? (Put in order from most to least important).

No	Causes of soil Erosion	Rank (1, 2.....12)
1	Slope steepness of the cultivation land	
2	Absence of conservation practices	
3	Over cultivation	
4	High Intensity of rainfall	
5	Over grazing	
6	Deforestation	
7	Others	

11. Do you think that the carrying capacity of the grazing area fits with the number livestock?

1, Yes 2, No

12. What is the trend of animal population in your area?

1, Increasing 2, Decreasing 3, The same 4, I do not know

13. Do you get advices from DAs and other agricultural experts regarding to soil and water

conservation practices? 1, Yes 2, No

14. What constrained you to be not benefiting from the extension service?

1, Their advice does not consider the economic background and ability of farmers

2, Because, I am not familiar with the work of the Das, so I am not benefiting

3, DAs are not interested to do so

4, If any other reason, please specify_____

15. Did you practice conservation structures in your farm land? 1, Yes 2, No

16. Did you adopt improved soil and water conservation practices? 1, Yes 2, No

17. On which farm land slope you construct soil and water conservation structures?

1, Flat 2, Gentle sloping 3, moderately sloping 4, Steeply sloping

18. Which soil and water conservation measures that you practice regularly in your farm land?

If your answer is Yes = 1, No = 2

No	Newly introduced Soil and Water conservation practices	Farmers' response	
		Yes	No
1	Soil bunding		
2	Fanya juu		
3	Stone bunding		
4	Check dams		
5	Waterways		
6	Others/specify		

19. Which traditional soil conservation practice that you practice in your farm land?

- 1, Contour farming 2, Traditional stone bund 3, Traditional ditches
- 4, Traditional water way 5, If others specify_____

20. If you are influenced by the technology adoption, please indicate your level of agreement with respect to the following traits?

Items	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
Improved soil bund increases the quality of soil fertility	1	2	3	4	5
Improved soil bunds are Possible to practice on small farm plots	1	2	3	4	5
No special rainwater harvesting that is available for farmers	1	2	3	4	5
Hill side terraces need more use of inputs	1	2	3	4	5
Improved soil bund and Cut-off drain require frequent maintenance	1	2	3	4	5

III. Professional Interview Guide for Development Agents

1. When did you start your job in this area?
2. Do you think that soil degradation is problem in your kebeles?
3. What problems have you identified on the measures of soil and water conservation practices?
4. What are the commonly practiced SWC practices in your kebeles?

5. What are the perceptions of farmers on constructing conservation measures regarding to them farm land?
6. What challenges do farmers share with you in soil and water conservation practices?
7. What are the factors that affect the adoption SWC practices regarding to farmers' farm land in your kebeles?

IV. Interview Guide Questions for the Agriculture and Natural Resource Office

Experts

1. Do you think that soil degradation is the problem in your woreda?
2. Please explain the processes that your organization has used for promoting SWC practices regarding to farmers' farm land?
3. What management technologies and strategies are now applied regarding to improve productivity of farm land?
4. What problems face the agriculture office to implement more effective SWC measures regarding to farmers' farm land?
5. How do you see the attitude of farmers' acceptance and practices of SWC measures in their farmland?
6. What is the role of the DAs experts in woreda office to increase soil-water conservation practices?

V. Discussion Points for Focus Group Members

1. What you expect from government to practice SWC measures?
2. What concerns do you have about adopting and implementing soil and water conservation practices in your farm land? Identify any challenges.
3. What type of conservation measures is being implemented?
4. What are challenges/ constraints face the farmers when they practice SWC?
5. How do you get the effectiveness of soil and water conservation measures in controlling soil erosion problems?
6. How do you see the extension workers service in your kebeles? Is that adequacy/sufficiency?

VI. Interview Protocol for Key Informants

1. How soil and water conservation structures introduced?
2. On what land type soil and water conservation method practiced?
3. Why the farmers use those methods?
4. How farmers practice in SWC measures in their farmland?
5. How do you see the extension workers service in your village? Is that adequacy/sufficiency?
6. What are the challenges / constraints face the farmers when they practice SWC, and not Practicing SWC?
7. If the farmers destruct the constructed SWC method; what is the reason of their destruction?
8. How do you see the agricultural productivity in your kebele? Is sufficient?

