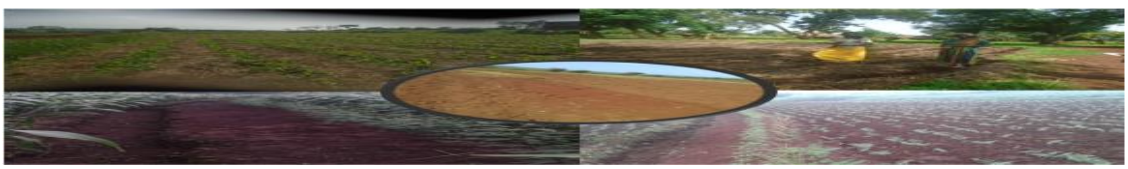
APPLICATION OF SOIL AND WATER CONSERVATION PRACTICE AS ITS CONTRIBUTION IN LIVELIHOODS OF SMALLHOLDER FARMERS' IN BAMBASI DISTRICT BENISHANGUL REGIONAL STATE (WESTERN ETHIOPIA)

M.Sc. Thesis



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M.Sc. Thesis

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A THESIS SUBMITTED TO THE DEPARTMENT OF AGROFORESTRY, WONDO GENET COLLEGE OF FORESTRY AND NATURAL RESOURCES, SCHOOL OF GRADUATE STUDIES, HAWASSA UNIVERSITY, WENDO GENET, ETHIOPIA

IN PARTIAL FULFILLMENET OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN CLIMATE SMART AGRICUTURAL LANDSCAPE ASSESSMENT

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APPROVAL SHEET-I

This is to certify that the thesis entitled "*The application of soil and water conservation practice as its' contribution in livelihood of smallholder farmers in Bambasi Distrct of Benishangul-Gumuz Region, Northwestern Ethiopia*" submitted in partial fulfillment of the requirements for the degree of Master of Science with specialization in *climate smart agricultural landscape assessment* of the graduate program of the *Department of Agroforestry*, Wendo Genet College of Forestry and Natural resources, and is a record of original research carried out by *Ashafi Mohammed* ID No. MSc/CSA/R005/10, under my supervision, and no part of the thesis has been submitted for any other degree or diploma. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

____________________	______________	_____________
Name of major advisor	Signature	Date
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Name of co-advisor	Signature	Date

APPROVAL SHEET-II

We, the undersigned, members of the Board of Examiners of the final open defense by *Ashafi Mohammed* have read and evaluated his thesis entitled **“The application of soil and water conservation practice as its’ contribution in livelihood smallholder farmers in Bambasi District of Benishangul Gumuz Region, Northwestern Ethiopia”** and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of Master of Science in Climate Smart Agriculture Landscape Assessment.

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Name of Chairperson	Signature	Date
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Graduate program coordinator	Signature	Date

Final approval and acceptance of thesis is contingent upon the submission of the final copy of the thesis to the CGS through the DGC of the candidate’s department.

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DECLARATION

I, Ashafi Mohammed, hereby declare that this thesis is my original work and has not been presented for a degree in any other University.

Ashafi Mohammed …………………Date…………………………

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ABBREVIATIONS AND ACRONYMS

BGRS	Benishangul Gumuz Regional State
CA	Conservation Agriculture
CIP	Crop Intensification Program
DFID	Department for International Development of the United Kingdom
DPSIR	Drivers pressures state impact responses
EDPRS	Economic Development and Poverty Reduction Strategies
FAO	Food and Agriculture Organization of the United nations
GovE	Government of Ethiopia
IFAD	International Fund for Agricultural Development
ISWC	Integrated Soil and Water Conservation
m.a.l	meter above sea level
MoALR	Ministry of Agriculture and Livestock Resources
MoFED	Ministry of Finance and Economic Development
EFCCC	Environment Forest and Climate Change Commission
CSA	Central Statistical Agency
NMABGRMSC	National Meteorological Agency Banishangul Gumuz Region Meteorological Service Center
SLMP	Sustainable Land Management Project
SWC	Soil and Water Conservation
UN	United Nations
WOCAT	World Overview of Conservation Approaches and Technologies
Ha	Hectare

ABSTRACT

This study is an investigation of application of soil and water conservation practices as its' contribution to the livelihoods of smallholders of Sonka, Mender 49 and Mender 46 Kebelesin Bambasi District of Northwestern Ethiopia. In order to address the objectives, both primary and secondary data were used for the study. The study applied a non-experimental design (explanatory) to collect primary data from a sample of 270 households drawn from the three Kebeles. Stratified random sampling technique was also used along with the simple random sampling technique. The data collected was then analyzed by inferential statistics such as chi-square and Microsoft office Excel. Perceptions of respondents of factors influencing the adoption of SWC technologies, extent of using these SWC practice, their application on farmers' livelihoods as well as their benefits were analyzed. In addition, the relationship between the number of SWC technologies adopted and factors affecting their adoption as well as an access to the livelihood assets were analyzed. Adoption extent of SWC technologies was analyzed by using descriptive statistics such as frequencies and percentages. The study found out that most adopted SWC technologies are crop rotation, level bund, agricultural inputs and FanyaJuu terraces, as well as the increase of availability of fodder for their livestock. The statistical test showed that farm size, crop yield, perception of soil erosion, availability of inputs supports, the availability of training and access on it as well as farmers' experience, Natural and social assets and steep slope have a connection with adoption of SWC technologies.

Keywords: Adaptation, livelihood assets, Agricultural technology, small holders, soil erosion

CHAPTER ONE

1. INTRODUCTION

1.1 Backgrounds of the Study

Globally, large areas of land are being affected by land degradation, partly resulting from unsustainable land use. This is particularly the case in developing countries, which are especially vulnerable to overexploitation, inappropriate land use, and climate change. Bad land management, including overgrazing and inappropriate irrigation and deforestation practices often undermines productivity of land (WOCAT, 2012). In the context of productivity, land degradation results from a mismatch between land quality and land use (Beinroth*et al*., 1994). Land degradation as a result is a biophysical process driven by socioeconomic and political causes (Eswaran *et al*., 2001).

Land degradation is related to climate and soil characteristics, but mainly to deforestation and inappropriate use and management of the natural resources, soil and water. It leads both to a non-sustainable agricultural production and to increased risks of catastrophic flooding, sedimentation, landslides, etc, and the effects of global climatic changes (Pla, 2000).

The problems of soil and water degradation and derivative effects are increasing throughout the world, partially due to a lack of appropriate identification and evaluation of the degradation processes and of the relations causes-effects of soil degradation for each specific situation, and the generalized use of empirical approaches to select and apply soil and water conservation practices (Sentis, 2002 & 2010).

In addition to the negative effects on plant growth and on productivity and crop production risks, soil and land degradation processes may contribute, directly or indirectly to the degradation of hydrological catchments, affecting negatively the quantity and quality of water for the population and for irrigation or other uses in the lower lands of the watershed (Sentis, 2010). The productivity of some lands has declined by 50% due to soil erosion and desertification. Yield reduction in Africa due to past soil erosion may range from 2 to 40%, with a mean loss of 8.2% for the continent. In South Asia, the annual loss in productivity is estimated at 36 million tons of cereal equivalent valued at US$ 5, 400 million by water erosion, and US$ 1,800 million due to wind erosion. It is also estimated that the total annual cost of erosion from agriculture in the USA is about US$ 44 billion per year, that is about US$ 247 per ha of cropland and pasture.

On a global scale the annual loss of 75 billion tons of soil cost the world about US$ 400 billion per year, or approximately US$ 70 per person per year. Thus, land degradation will remain an important global issue of the 21st century because of its adverse impact on agronomic productivity, the environment and its effect on food security and the quality of life (Eswaran *et al*, 2001). Soil loss in Ethiopia showed a pattern of regional differences that closely followed variations in rainfall and topography. The development of regional strategies to minimize agricultural erosion is likely to be more effective than a single national policy (Lewis *et al*., 1988).

The study carried out in different areas in Ethiopia showed that the effects of soil degradation and water shortages on crop productivity have induced researchers to introduce some innovative practices such as mulching, bunding, contour ridging, ripping, minimum tillage and others check the down ward spiral in agricultural production. Varied soil and water conservation practices requiring varied farmer inputs have been promoted among farmers for over a decade now (Mulenga, 2003;Haggblade & Tembo, 2003; Chelemu & Nindi, 1999).

1.2 Problem Statement

This study is an investigation of application of soil and water conservation practice as it's a mechanism for contribution in livelihood in livelihoods of smallholder's farmers in Bambasi District in Benishangul Regional state, North western Ethiopia. Land degradation has been recognized as a major problem in highlands of Ethiopia for a long time, but now a day the issue of land degradation is in reality a problem of all areas in the country. Due to topography and climate, land degradation and erosion have long been assumed to be severe and a major reason for the poverty and food insecurity in the country. As small-scale farming is the backbone of agriculture production in the country, farmers have to use available land in order to increase agricultural productivity as well as improve their living standards. To achieve this, however, farmers have to adopt various technologies including soil and water conservation technologies. In an effort to improve agricultural productivity, reducing poverty and at the same time reducing land and /or soil degradation, government, private institutions and NGOs have introduced and promoted the use of various soil and water conservation technologies and sustainable agriculture in different parts of the country including Bambasi District of Benishangul Gumuz Region. Moreover, the additional capacity of SWC practices towards enhancing the potential of smallhoders to adapt to the impacts of climate change has not been adequately studied. On the other hand, there is a remarkable difference among smallholder farmers with regard to the use of SWC practices on their farms, the preference and extent to which they carry out those practices which need to be understood by both planners and development agents working in such interventions. Filling this knowledge gap would therefore help to be aware of the multiple contributions of SWC technologies to smallholders' farmers, design more effective SWC technologies, and helps to convince farmers to adopt those SWC technologies.

1.3. Research Objectives

1.3.1 General Objective

The general objective of this study was evaluating the application of soil and water conservation practices with respect to benefit outcomes as well as assessing their contribution in the livelihoods of smallholder farmers in the study area.

1.3.2. Specific objectives

1. To assess the extent to which farmers have implemented soil and water conservation technologies in the study area**;**

2. To analyze the benefits of SWC practices to the adapt to climate change impacts by smallholder farmers

CHAPTER TWO

LITERATURE REVIEW

2.1 Smallholder Farmers Overview

Approximately 2.5 billion people live directly from agricultural production systems, either as full or part-time farmers, or as members of farming households that support farming activities (FAO, 2008). Overall, smallholder farmers are characterized by marginalization, in terms of accessibility, resources, information, technology, capital and assets, but there is great variation in the degree to which each of these applies (Murphy 2010).In addition, smallholder farmers defined as those marginal and sub-marginal farm households that own or/and cultivate less than two hectares of land (Singh *et al*., 2002). On the other hand, according to the (IAASTD, 2009) there are 1.5 billion men and women farmers working on 404 million small-scale farms of less than two ha. However, the two ha farm size is not a universal characteristic.

2.2 Smallholder farmers' perspective in Africa

In Africa, Smallholder farmers play an important role in livelihood creation amongst the rural area (Adeleke *et al*., 2010), In fact, most African smallholder farmers defined on the basis of land and livestock holdings, cultivate less than 2 hectares of land and own only a few heads of livestock. In areas with high population densities, smallholder farmers usually cultivate less than one hectare of land, combination with livestock of up to 10 animals (Dixon et al, 2003).

According to the study conducted by Dixon et al (2003), smallholder farmers are categorized on the basis of the agro-ecological zones in which they operate; the type and composition of their farm portfolio and landholding; and/or on the basis of annual revenue they generate from farming activities.

2.2.1 Smallholders farmers and Agriculture in Ethiopia

In case of Ethiopia, most land is formed by very small holdings, primarily for household subsistence. The Central Statistical Agency (CSA)(2007) classifies Ethiopian farms into two major groups: smallholder farms. The majority of farmers in Ethiopia are smallholder farms, producing mostly for own consumption and generating only a small marketed surplus. In 2007/08, smallholder farmers (12.8 million farmers) cultivated 12 million hectares of land or 96.3 percent of the total area cultivated the main crops (cereals, pulses, oilseeds, vegetables, root crops, fruits, and cash crops).

2.3 Land and Soil Degradation

2.3.1 Globally

Land degradation remains a major threat to the world's ability to meet the growing demand for food and other environmental services. This study adopted the defining of land degradation as presented by Reynolds (2001), land degradation is a persistent reduction in the biological and economic productivity of terrestrial ecosystems, including soils and vegetation.

Land degradation is a gradual negative environmental process which can be accelerated by human activities. The negative effects generally touch on food security, economic wellbeing, and environmental conditions; thus explaining the reason behind much attention given to land degradation worldwide (IFPRI, 1997). Forms of degradation vary with the causative factors: loss of topsoil, terrain deformation mass movement or water and wind erosion, loss of nutrient and organic matter, salinization, acidification, pollution (chemical deforestation, compacting, crusting waterlogging substance of organic soils (physical deterioration) of the total degraded area, overgrazing, agricultural mismanagement, deforestation and over exploitation of natural resources are said to account respectively for 49,24,14, and 13 percent (Oldman et al 1991; Batjes, 2001 and IFPRI, 1997). The main direct drivers (pressures) contributing to land degradation in sub Saharan Africa (SSA) are non-sustainable agriculture, overgrazing by livestock, and overexploitation of forests and woodlands. Land degradation affects about 300 million hectares of land in Latin America while in North America; about 95 million hectares are affected as well as in Europe, 157 million hectares affected by water and wind erosion alone. For example, in China alone, between 1917 and 1990, the area of arable land was reduced by an area equal to all the crop land in Denmark, France, Germany and The Netherlands combined mainly because of land degradation. Much of the recent increase in area under agricultural land continues to occur mostly in developing countries, mainly Africa and Latin America (Houghton, 1994).

2.3.2 The Status of Land degradation in Africa

Nearly one thousand million hectares of vegetated land in developing countries are subjected to various forms of degradation, resulting in moderate or severe decline in productivity. About 490 million hectares in Africa are affected by different types of degradation from the approximately 2976 million hectare total land area in Africa. Of this total land, 72 percent are problem of soil with different production constraints such as soil acidity, low fertility, saline and poorly drained soils. Poor and inappropriate soil management is the main cause of physical and chemical degradation of cultivated land (Nabhan et al, 1997). Reviewing data from 37 countries in Sub-Saharan Africa (SSA), Drechsel et al. (2001) confirmed a significant relationship between population pressure, reduced fallows and soil nutrient depletion. Detailed field observation and measurements showed that over 55 percent of the farms sampled lacked any form of soil and water conservation technologies. Sheet erosion was the most dominant form of soil loss observed in over 70 percent of the farms. SLM seeks to increase production through both traditional and innovative systems, and to improve resilience to the various environmental threats (TERRAFRICA, 2011).

2.3.3 The case of Land Degradation and Land Use Policy in Ethiopia

Decreasing soil fertility, for example, reduces vegetation cover which, in turn, increases the potential for soil loss and even lower fertility. The study conducted by Clay & Lewis (1996) showed that farmers themselves said that the productivity of the land is declining and that often this is due to soil erosion. Farmers have observed a decline over time in the productivity of a full 50 percent of their holdings. Two reasons for the declining productivity of the farmers" farms focus on: over-cultivation and soil erosion. Secondly, only to over- cultivation as a perceived cause of declining productivity is soil erosion.

The conservation of scarce land resource is essential to the long-term viability of agriculture in Ethiopia. Without proper attention, the downward spiral of environmental deterioration in affected areas will be inevitable. Land use Policy Planning was implemented for the first time in 1979 by the Government of Ethiopia, through the Regulatory Department of the Ministry of Agriculture as part of the Crop Intensification Program (CIP).

2.3.4 Impact of global land degradation on agricultural production

Globally, there are few studies of the impacts of degradation on agricultural production. An analysis of results of GLASOD (IFPRI, 1997), has shown that there has been a 17 percent cumulative productivity less over 45 years as a result of degradation. A study of the impact in Africa based on field data estimated that yield reductions due to past erosion may range from 2 percent to 40 percent with a means of 8.2 percent for the continent and 6.2 percent for sub Saharan Africa. If the accelerated erosion continues unabated, yield reduction by the year2020 may be 16.5 percent for the continent and 14.5 percent for sub Saharan Africa. Evidence from four Southeast Asians and three Middle Eastern countries indicates a degradation induced decline in productivity, greater than 20 percent (IFPRI, 1997).

2.4 Sustainable Livelihoods

According to different organizations, DFID (1999) and FAO (2006) as well as various authors, including Chambers & Conway ,1992; Krantz, 2001 and Scoones (1998) Sustainable livelihood was defined as: a livelihood which comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks maintain or enhance its capabilities and assets, while not undermining the natural resource base. Further, livelihood is also sustainable when it contributes to net benefits to others livelihoods at the local and global levels and in the short and long term (Chambers & Gordon, 1992). So far, Morse *et al*., (2009) stated that SLA is an example of the multiple capital approach where sustainability is considered in terms of available capital (natural, human, social, physical and financial) and an examination of the vulnerability context (trends, shocks and stresses) in which these assets exist. The framework also offers a way of assessing how organizations, policies, institutions, cultural norms shape livelihoods, both by determining who gains access to which type of asset, and defining what range of livelihood strategies are open and attractive to people(Carney, 1998). On the word of DFID (1999), Sustainable Livelihood has three main elements: Livelihood resources, Livelihood strategies, and Institutional processes and organizational structures. And it is better to note that livelihoods vary significantly within a country, from rural to urban areas, and across countries (FAO, 2006).

Vulnerability Context

Vulnerability context refers to the seasonality, trends, and shocks that affect people's livelihoods. The key attributes of these factors are that they are not susceptible to control by local people themselves, at least in the short and medium term (DFID, 2000) (Figure 1).

Natural capital

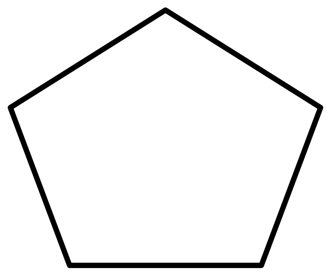
(Natural resources, including land, water, air etc and environmental services)

Social Capital

(Network, social relations, associations)

Physical Capital

(Equipment, buildings, roads)



Human capital

(Ages,labour,skills,knowledge, etc.)

Financial capital

(income, credit/savings, other economic assets)

Figure 1: The five capitals of sustainable livelihood (Scoones 1998)

Policies and institutions

As defined by DFID (2000) policies and institutions are those which influence rural household's access to livelihood assets and are also important aspects of livelihood framework. Institutions are the access to capital of different kinds to the means of exercising power and so define the gateways through which they pass on the route to positive or negative livelihood adaptation (Scoones, 1998).

Livelihood strategies

According to (DFID, 1999) the term livelihood strategies are defined as the range and combination of activities and choices that people make in order to achieve their livelihood goals, including productive activities, investment strategies, reproductive choices, etc. Livelihood strategies are composed of activities that generate the means of household survival and are the planned activities that men and women undertake to build their livelihoods (Ellis, 2000).

Livelihood outcomes

Livelihood outcomes are the achievements of livelihood strategies, such as more income (e.g. cash), increased well-being (e.g. non material goods, like self-esteem, health status, access to services, sense of inclusion), and reduced vulnerability (e.g. better resilience through increase in asset status), improved food security (e.g. increase in financial capital in order to buy food) and a more sustainable use of natural resources (e.g. appropriate property rights) (Scoones, 1998).

2.5 Soil and Water Conservation Technologies as its contribution in livelihood

2.5.1 Definitions and classification of soil and water conservation

I. Sustainable Land Management

Like other composite approaches to agricultural development, soil and water conservation (SWC) has numerous definitions. Over time the conception of SWC has changed from an initial emphasis on structures to reverse soil erosion to an important part of sustainable land management. UN Summit (1992) and WOCAT have defined Sustainable Land Management (SLM) as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. At the same time as, Terr Africa partnership (2005) has further defined sustainable land management as the adoption of land use systems through appropriate management practices. Sustainable Land Management (SLM) is crucial to minimizing land degradation, rehabilitating degraded areas and ensuring the optimal use of land resources for the benefit of present and future generations.

According to WOCAT (2007), four different conservation measures types exist: Agronomic, vegetative, structural and management measures. Agronomic measures include soil management, such as contour cultivation, direct planting, soil cover, crop mixtures and rotations. These measures are normally cheap but very effective. Manuring and composting also belong to these measures and have a big influence on soil fertility. Agronomic measures are normally linked with annual crops and repeated every year or cropping season. Terraces, bunds and banks are the structural measures in most of the cases; they are built to prevent movement of eroded soil.

There are formal institutions such as rural land committee, and informal institution like religious which are working for soil and water conservation practice and solving rural land use conflict in the study area.

III. Major Soil and Water Conservation Technologies used in Ethiopia

As described by REMA (2010), the soil and water conservation measures used are for sloping land in order to sustain agriculture and Agroforestry production. There are various measures and application of soil and water conservation used in the whole country.

The three main techniques considered are agronomic or biological measures, soil management strategies and mechanical or physical methods. Suggested measures in these on farm erosion control strategies are: Agronomic or biological measures utilize the role of vegetation in helping to minimize erosion. Soil management is concerned with ways of preparing the soil to promote dense vegetation growth and improve its structure so that it is more resistant to erosion. Mechanical or physical methods depend upon manipulating the surface topography, for example, by installing terraces to control the flow of water. Their main role is in supplementing agronomic measures, being used to control the flow of any excess water that arises (REMA, 2010). Mechanical methods, including bunds, terraces, waterways, and structures such as vegetative barriers or stone lines installed on farm. The most soils and water conservation used in Ethiopia are presented in Table 1.

Table 1: Major soil and water conservation measures used in Ethiopia

Agronomic or biological measures	**Soil management strategies**	**Mechanical or Physical Method**
Mulching Crop Management -Cover crops -Improved fallows -Intercropping -Planting Pattern/Time -Crop rotation Agroforestry	Conservation Tillage -Minimum tillage -Improved tillage -No-till Contour Tillage Strip farming	Terracing Contour Bunds Infiltration Galleries Waterways Gully Controls -Stabilization structures -Stone check dam -Gabion Baskets -Reno Mattresses -Stone lining
***Source**: Ethiopia Environmental Protection Authority (EEPA), 2010.*		

One research conducted in Ethiopia has shown that the use of living hedges has greatly improved the soil properties where after 2 years, living hedges reduced runoff to less than 2 percent and again findings of a study based on soil and water conservation investments in Ethiopia showed that 76.2 percent of farm holdings have received investments in the form of radical terraces, hedgerows, grass strips, or anti-erosion ditches, and that such investments are concentrated on the steeper slopes (Clay & Reardon, 1994).

IV. SWC technologies in Benishangul-Gumuz Regional State (BGRS)

The land in the study area is very shallow and susceptible to high soil erosion. They are using organic fertilizers, terraces, normally, the government have helped the farmers by providing them training on how to make the land more productive by shifting from substance farming system to the agricultural market oriented system which will help farmers to develop themselves and getting high yields of agricultural productivity.

2.5.2 Empirical studies done by SLM in BGRS

Various studies have been done on Sustainable Land Management. According to Simon et al., (2012) and Alufah et al., (2012); education, distance of farm from homestead and number of farm parcels have negative effect on adoption of SWC technologies. The findings of the study reinforce the fact that in order to achieve sustainable watershed management, institutional and economic factors should be given special attention (Simon et al., 2012). As revealed by Toborn (2011) FAO has published the criteria used to explain adoption of SWC technologies, including i) farmer and farm household characteristics, ii) farmer biophysical characteristics, iii) farm financial/ management characteristics, and iv) exogenous factors. Further, the findings of Gebreselassie *et al*. (2009) also confirmed that soil bunds stabilized with vegetative measures are better held the soil in-situ and improve inter-terrace soil physical and chemical properties compared to the non-conserved fields. In agricultural dependent countries, soil and water conservation is crucial in improving the livelihoods of the rural farm households Keyser & Mwanza (1996). The article, reviews of adoption of conservation technologies in Sub-Saharan Africa undertaken by Haggblade *et al*., (2004) also Smallholder farmers in the micro-catchment who adopts SWC technologies attain higher productivity.

2.6 Application of soil and water conservation in Ethiopia

Application SWC management activities are very crucial for achieving and sustaining food security in farm households. As the research report by Adimassu *et al*. 49, the values reflected the perceived degree of importance of each SWC practices based on their criteria according to farmers gave higher scores for criteria related to technical for most SWC alternatives (SB+Vg, SB+EG and SB+Ss). This implies that these SWC practices are more technically importance than economically efficient. The overall average shows that farmers gave the highest total score for SB+Eg followed by SB+Ss and SB+Vg. In all criteria, farmers gave the lowest total score for soil bund alone (SB). This is because; in SB alone there is no grass or shrub to improve its technical and financial efficiency. So, it is crucial to plant grasses and shrubs on soil bunds to re enforce the structures and increase the financial efficiency of the soil bunds.

2.7. Theoretical and conceptual framework

2.7.1 Theoretical Framework

Why the Adoption of SWC Technologies?

According to Ervin and Ervin (1982), personal factors (education level, attitude of farmers towards SWC conservation), Physical factors (soil erodability, topography, etc.), economic factors (level of economic return, debt, off-farm income, farming type, risk aversion) and institutional factors (training and technical assistance, cost sharing or government assistance) influence farmers' decision on soil and water conservation.

Soil and Water Conservation practice to an Adaptive capacity:

According to the IPCC (2007) climate and weather changes are linked to examples as: hail storms, increases of (intensive) rainfall which "increased flood frequency and intensity" and increased temperature of "approximately 1°C in Mesoamerica" over the last decades. Increased temperature formed water availability problems and droughts in the valleys due to increasing evapo-transpiration "changes in the spatial and temporal distribution of precipitation" (Climate Investment Funds, 2011).

Three aspects of the adaptive capacity are based on the definition of IPCC (2012): 1) Strengths (e.g. ability to work and knowledge about solutions), 2) Attributes (e.g. tools required for maintenance of SWC practices) and 3) Resources.

2.8.2 Conceptual Framework

In this study, DPSIR Framework (Figure 2.) in association with Sustainable Livelihoods and Ecosystem Services is used to help carrying out an integrated analysis of Soil and Water Conservation technologies in Bambasi District.

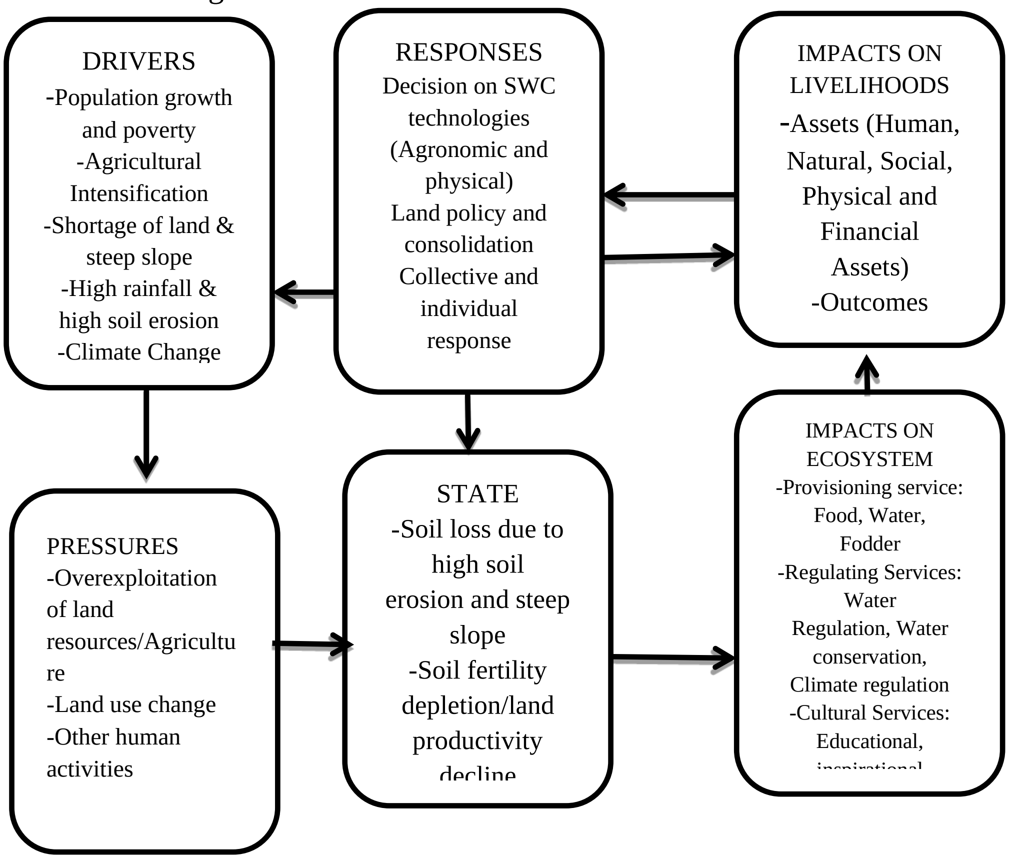


Figure 2: DPSIR Framework (Adapted and modified from (LADA, 2009))

The human activities related to the development of agriculture and both the supply of ecosystem services and livelihoods of smallholders is a result of the perception of sustainable livelihoods, government and society perform different responses to control the state as well as promoting the impacts of the adoption of these actions (responses).

CHAPTER THREE

MATERIAL AND METHODS

3.1 Description of the study area

3.1.1. Geographical location

The study was conducted in Benishangul Gumuz regional state, in Bambasi Distirct, which is one of the twenty Districts of the region. Bambasi District is found 45 km far from Asossa town which is the capital city of the region. was extracted and presented in Figures and the woreda is located at 9^{o} 57’ 12.4’’ N Latitude and 34 ^{o} 39′ 21.7″ E Longitude. (Figure 3).The District is bordered with Oromia regional state and Maokomo special District in the south and south west and, Asossa District in the west and Oda Buldegelu Districtin in the north east.

Administratively, the District is divided into 38 kebeles. 19 kebeles are inhabited by indigenous people, 17 kebeles are resettlements areas created during the Dreg regime and 2 kebeles are under the municipality of Bambasi town. And also new refugee camp is found in the District. Based on thedocument analysis of the Bureau of Agriculture, Woreda Agricultural and rural development office and Woreda rural land administration and use office, there are several Kebeles which have encountered intense land cultivation in the Woreda. These include Sonka, Keshmando-qutir 5, Sisa qutir1, Bashimakergige, Womaba-Selema, Bambasi 02, Amba 16, Mutsa, Jematsa, Sonka and Mender 55.

3.1.2. Population

Based onCSA (2007) data , the total population of Bambasi district is about 70,350 population size recorded. The populations found in this district are combines a varieties of ethnic groups, such as Berta,Amara, Oromo and Tigre. And there are also a refugee from N. Sudan resettled in 2014 G.C which is the total population is 25078 peoples.

3.1.4 Major economic activities in the study area

The main economic income bases of the District is farming, fishing and mining in Dabus River is further practiced by Berta ethnic group both as a supplementary economic and as food sources where major crops are maize and sorghum. The average productivity of maize per hectare in Bembasi is stated to be 60 quintals with the application fertilizers and for sorghum, it is about 25 quintals. Experts still believe the yields can be increased. A Sustainable Land Management (SLM) project is on-going and soil and water conservation activities are widely undertaken with the support of different NGOs and the regional agricultural research center. Fertilizer application of SWC has been improving in the last couple of years and now the communities have recognized that it possible to apply. However, the practice of SWC is still low compared to other developed regions.

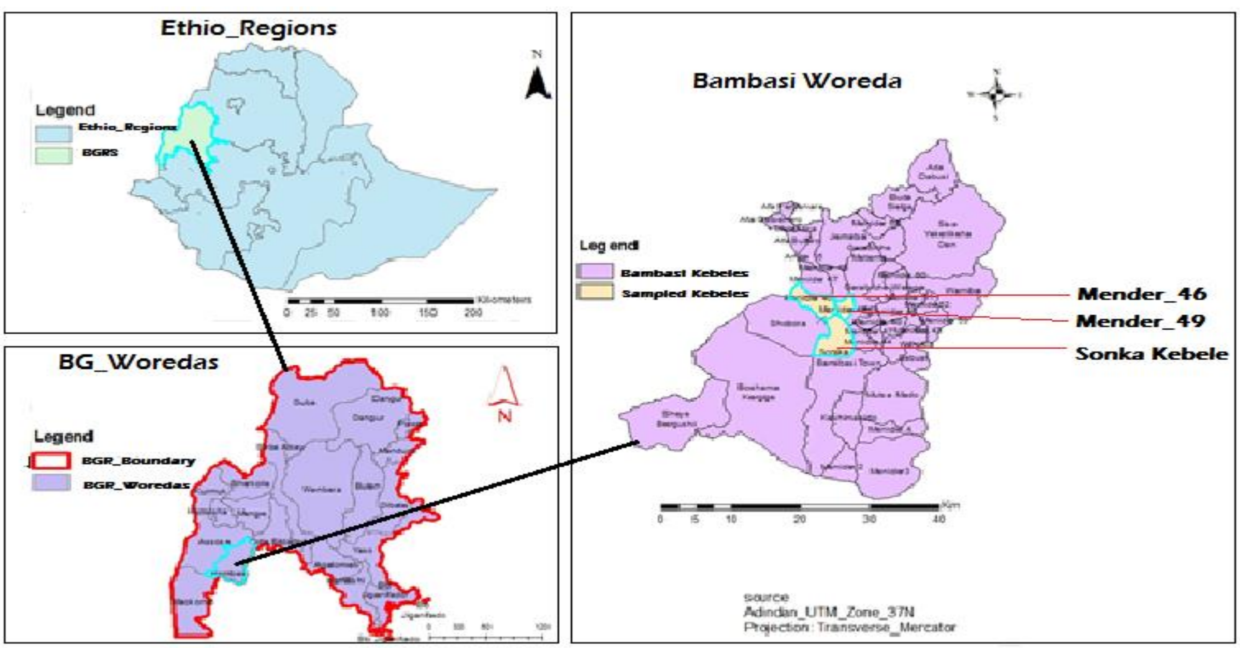


Figure 3: Location of the study area

3.1.5 Climate

Climate data from the nearest meteorological stations Amba 16 (only rainfall, from 2005-2018) The average annual rainfall is 1381.42 mm, while the mean annual maximum temperature is 28.37 °C and the mean maximum monthly temperature reaches to its peak during March followed by April and February, with a temperature of 32.69^{o}C, 32.05^{o}C and 31.96^{o}C, respectively; whereas, the lowest mean minimum monthly temperature occurs during December with a temperature of 13.28^{o}C. The area is characterized by unimodal rainfall distribution with the rainy season extends from March to November and one distinct short dry season extending from December to February (Figure 4). Typically during the onset of the main rainy season, the first two months receive small amount and gradually reach to its peak in August. More than 55% of the mean annual rainfall falls from June to August.

This climate diagram of Bambasi District shows water stress in January, February and November, and excess water in May, June, July August and September. The red line is temperature, measured on the left axis. The purple line is precipitation, measured on the right axis

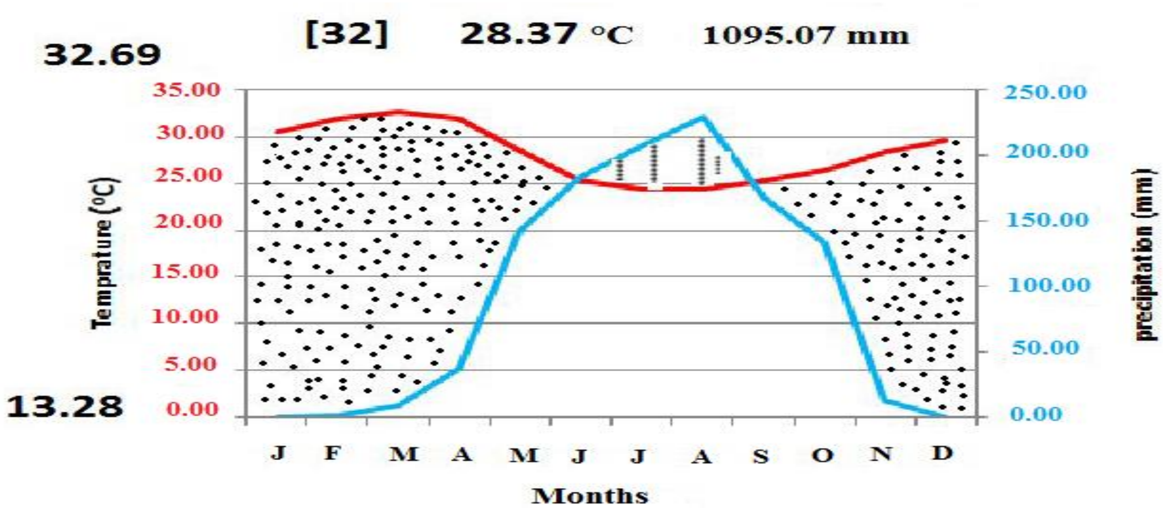


Figure 4: Climate diagram of Bambasi District (Data source: NMA, BGR, MSC 2019)

3.1.3 Land use and Farming System

The District covers an area 472,817 hectares, of which 221,016 hectares potential used for cultivation. But now a day only 72,379 hectares are cultivated land, 10,000 hectares are pastureland, 63,756 hectares are non-cultivated land and 174,820 hectares are natural and plantation forest area, 1,200 hectares are mountain area, 1,797 hectares are irrigation area, and 228 hectares are perennial crop area. The major food crops or cereals grown in the area are maize, sorghum and teff. Oil crops and others crops are also produced in the area. The average land holding is 4.65 hectares per household.

3.2 Research Methodology

3.2.1 Study Design

Descriptive statistics of socioeconomic and environmental characteristics, geographical characteristics, factors of adoption of SWC technologies and their benefit were analyzed. This statistics included descriptive and chi-square statistics. These help to outline the influence of farm characteristics and socioeconomic and environmental characteristics as well as their expected outcomes from adoption of SWC technologies in their farms location.

3.2.2. Study Population

The study was target smallholder-farmers whose farms were located in areas prone to soil erosion and applied soil and water conservation technologies in their farms.

3.2.3 Sample Size

(i) Sample Size determination

The sample size of this study was determined largely from the following factors:

(i) the total number of population living in the study area,

(ii) the desired level of confidence,

(iii) The acceptable margin of error.

The sample size of this study was calculated based on the following formula Krejcie & Morgan (1970):

$$n = \frac{x^2 N.P(1-P)}{ME^2(N-1)+(X2P(1-P)}$$

Where:

n: required sample size

X: Z value (confidence level – standard value of 1.96)

N: total number of farmers living in the study area:

P: Standard deviation (standard value of 0.5)

ME: Margin error at 5% (standard value of 0.05)

$$n = \frac{1.96^2 x 2406 x 0.5(1-0.5)}{0.05^2(2406-1)+1.96^2 x 0.5(1-0.5)} \approx 331$$

3.2.5 Sampling Techniques

The stratified random sampling technique was used. It was stratified according to the farm location; hillside or marshland. In fact, due to the topography of the study area this were an appropriate factor for the subject of the study as some farms are located in hillside while others are in marshal. The research covered three Kebeles of Bambasi District which have an experience of SWC practices. In each Kebele, some households were selected randomly.

3.2.6 Instrument of Data Collection

The method which was used during the research was a questionnaire. In fact, the questionnaire is a set of questions that have been prepared to ask a number of questions and collect answers from respondents relating to the research topic. The questionnaires were open-ended questions.

3.2.7 Method of data collection

For collection of primary data, face to face interview and observation methods were used.

(i)Interview

Both households and key informant interviews were done. The interview with household head was used to capture general characteristics of the household as well as information regarding SWC practices, technologies and farm size. The interview with key informant was also used to capture data from them on one-on-one conversation. These were allowed the researcher to collect reliable and accurate data needed in order to achieve the specific objective of the research. These include information regarding the SWC practices, SWC technologies used in the area, the factors influencing adoption of these SWC technologies, their effects on the livelihoods of smallholder farmers as well as their benefits.

(ii) Observation Method

In addition to the survey methods that were used for collecting primary data, observation methods were also suitable for the topic study. Observation were employed based on a schedule designed to collect data related to the types of SWC practices, SWC technologies used, type of crops, livestock and type of soil erosion, including gully erosion and the location of the farm and its size.

3.2.8 Methods of Data Analysis

Descriptive statistics were used in the data analysis and Chi-square was also used in hypothesis testing. Application of the appropriate statistic helps a researcher to decide if the difference between the two groups‟ scores is big enough to represent a true rather than a chance difference. Choice of appropriate statistical techniques is determined to a great extent by the research design, hypothesis, and the kind of data that was collected. In fact, after data collection, the data was edited and coded and subsequently, the data were entered into SPSS.

The descriptive statistics permit the researcher to meaningfully describe many pieces of data with a few indices. The major types of statistics are measures of central tendency, percentages, pie charts and bar graphs was used in the data analysis. The Chi-square (x2) was computed using the following formula:

$$\chi^2 = \Sigma\ (O\text{-}E)^2/E$$

Where:

O – Observed frequency

E – Expected frequency

Σ (O-E) ^{2} – Sum of the squares of the differences between Observed and Expected frequencies. The χ2calculated was compared with χ2critical at a significance level of 0.05 and degrees of freedom which was determined as follows:

Degrees of freedom (df) = (r – 1) (c – 1)

Where r: number of rows

c: number of columns

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. SOCIO DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

A total of 331 questionnaires were planned. Out of which 270 questionnaires were responded. This was because some of the respondents were too busy that they were not able to attempt the whole question. This response was good enough and representative of the population and conforms to Mugenda and Mugenda (2003) stipulation that a response rate of 70% and above is excellent.

All 270 samples of respondents were all farmers and relied on natural resources for their basic needs. The study results indicated more than three quarter of the respondents (87 %) are smallholder farmers with farm size below two hectares, while only quarter (13%) of the sampled respondents have farms with size of greater than or equal to two hectares.

Four age groups of respondents were identified: below or equal to 20, between 21 and 40, between 41 and 60 and then greater or equal to 61 years old. The findings indicate that most of the respondents (83.7%, n=226) are in the age vary from 21 to 60 years (Table 2). The average age is 44.17 years for all respondents, max=63 and min=18 years. Additionally, the average age for women is 42.5 years and 45.8 years for men.

Table 2: Characteristics of respondents in the study area (N=270)

HH characteristics (Variable)	Parameter	Frequency	Percent
Sex	Male	180	66.7
	Female	90	33.3
Age of the respondent	≤ 20	4	1.5
	21-40	125	46.3
	41-60	101	37.4
	≥ 61	40	14.8
Household family size	1-3 numbers	56	20.7
	4-6 numbers	203	75.2
	7-9 numbers	8	2.9
	>10 numbers	3	1.2
Marital status of Household	Married	224	83
	Divorced	2	0.7
	Widow	31	11.5
	Single	13	4.8
Education level	No education	56	20
	Read and Write	199	73
	Primary	9	3.33
	High school/higher education	6	2.22
Farm size (ha)	< 0.3	93	34.44
	0.3 - 0.9	61	22.59
	0.9 - 1.5	47	17.41
	1.5 - 2.0	33	12.22
	≥ 2	36	13.33

The distribution of the percentages showed that females are 33.3% (n=90) while males are 67.7% (n=180) (Table 2).The results indicate that majority of the respondents can read and write (73%) and very few were with diploma certificate (2.22%). The marital status varies a lot by age, sex and in less extent by area of residence along with living conditions. The respondents aged below 21 years are all single 4.8% (n=13), married are 83% (n=224), widowed are 11.5% (n=31) and divorced are 0.7% (n=2) (Table 2).The results show that 55 households with members ranging from one to three persons are 20.7% (n=56), households with members ranging from four to six persons are 75.2% (n=203), family size ranging from seven to nine, are 2.9% (n=8). The average family size is 4.48, min=1 person while max= 14 persons and the standard deviation is 1.156 (Table 2).

The results of the study showed that a great number of farmers are smallholders; as a result their farms are less than 2 hectares. The study indicates that 34.44 % (n=93) holds the farm with size less than 0.3 hectares, 22.59 % (n=61) have farms vary between 0.3 – 0.9 hectare, 17.41 % (n=47) have farms with size vary between 0.9 – 1.5 hectares, 12.22 % (n=33) have farms with size vary between 1.5 – 2.0 hectares while the farmers with land greater than or equal to 2 hectares are only 13.33% (n=36). The average size of respondents‟ farms is 1.23 ha. The majority of farmers' land size varies from 0.3 to 0.8 ha (Table 2).

4.2. LAND USE AND AGRONOMIC PRACTICES

4.2.1 Land use

According to the topography of the study area, land use type is determined according to the location of the farm as well as slope. Farms located in marshland are used for only farming, while those located on hillsides are used either for farming annual crops, coffee plantation and forest to the very steep slope. According to the study results, the land uses were identified into three groups: 74.8% (n=202) are engaged in farming only, 22.6 % (n=61) are in farming combined with farm, forest, and the remaining 2.6% (n=7) are combining three land use (farming, coffee and forest) (Figure 5)

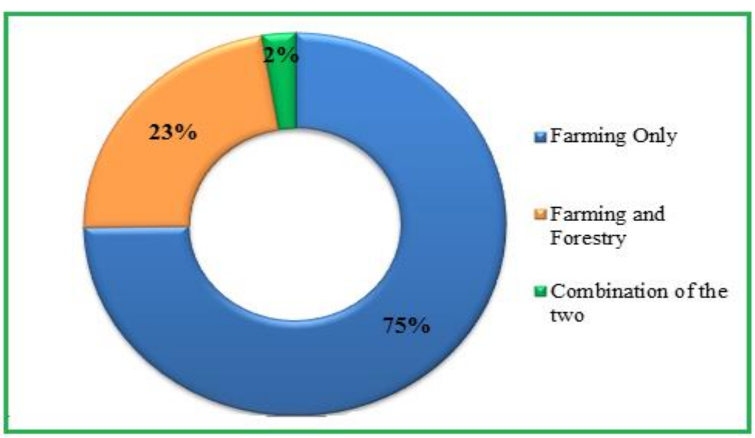


Figure 5: Types of Land use (Field Survey, 2019)

4.2.2Types of Crops

Farming system which is overwhelmingly smallholder in nature is characterized by intensive organic systems and involved the combination of food, fodder and tree crop. Crop rotation and use of some soil and water conservation techniques are typically practiced. Number of crops cultivated in the study area ranges from one to four, according to the farm location and priority of crops, including the most dominants crops in the study area are sorghum 92.2 %, with a proportion of respondents, followed by beans (*Phaseolus vulgaris*) with a proportion of 88.5% respondents, the next most frequent crops are vegetables 27.4 %, maize 17.4, Mango is 5.9 and others (sugar and Banana) are 4.4 % (Table 3). This is similar to the findings of a study done by Amanze*et al*., (2010).

Table 3: Types of Crops grown by sample households

Type of crop	Frequency	Percentage %
Sorghum	249	92.2
Bean Varieties	239	88.5
Vegetables	74	27.4
Maize	47	17.4
Mango	16	5.9
Others (Ground net, Sugar can and Banana)	12	4.4

Plate 1*: Some crops grown in the study area (Sorghum and Bean)*

4.2.3Types of livestock

The findings revealed that some of the respondents do not hold any livestock while others have at least one type of livestock. The results indicate that 4.4 % do not own any type of livestock while those who own at least one type of livestock are 95.6 %. The major domestic animals raised in the study area are cattle, goats, sheep, chickens and donkeys. According to the study findings, cows 89.6 % are very dominant, followed by goats 79.6 %, chicken 61.1%, sheep 46.3 %, and donkey 5.9% respectively (Table 4). It has also found that respondents who have at least one cow are 23.7 % (n=64) while those who have at least two different livestock are 84.44%.According to Shiferaw & Holden (1998), livestock are generally considered as assets that could be used in the production of process or be exchanged for cash or other productive assets. Livestock may reduce the economic impact of soil erosion and thus lower the need for soil conservation.

Table 4: Type of livestock

Type of Livestock	Frequency	Percentage %
Cows	242	89.6
Goats	215	79.6
Chicken	165	61.1
Sheep	125	46.3
Donkey	16	5.9
No Livestock	12	4.4

Plate 2: Livestock reared in the study area

4.2.4 Status of Soil erosion

Soil erosion is worldwide known as a major problem, especially in developing countries, where many tons of soils are washed away due to unsustainable land use. According to the research findings, 44 % respondents confirmed having a problem of soil erosion while 56 % pointed out that there is no soil erosion on their farms. During the study, it was found that; soil erosion 23 % and soil fertility depletion 21 %. Respondents told the soil erosion and soil fertility depletion in in-situ as a serious environmental issue in the study area. The study results present these problems, according to the farm location, due to the topography, heavy seasonal rainfall, and unsustainable land use for agricultural purpose lead to the decrease of crop productivity. Relatively fewer respondents in marshland indicated soil erosion and decline in soil fertility as a problem while a higher proportion of respondents on hillside areas perceive these problems (Figure 6).A study done in Ethiopia by FAO (2006) noted that the country faces moderate to severe soil erosion on 50 percent of its land surface. Therefore, the proportion of farmlands affected by soil erosion is either comparatively lower or it is concentrated in certain areas.

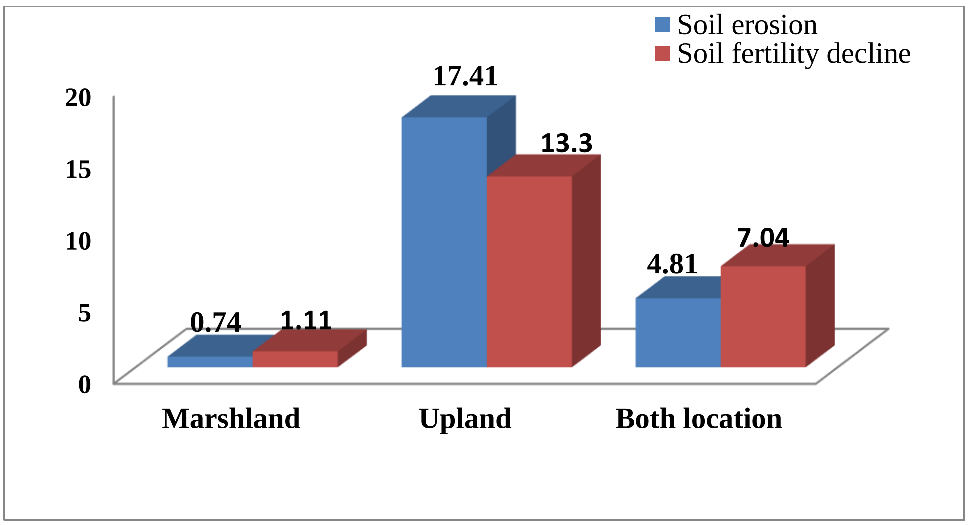


***Figure 6**: Soil erosion, soil fertility and farm location (Field Survey, 2019)*

4.2.5. Perception on Extent of Soil erosion and Soil fertility decline

The extent of soil erosion in the study area have been identified into three categories; extent into low, moderate and high, while the level of soil fertility was identified as low, medium and high. According to the findings, respondents mentioned the extent as well as their perceptions; farmers have classified soil erosion into two categories; 1) degree of soil erosion by water. Low 35.92 %, medium, 45.56 % high 18.52 % and 2) degree of soil fertility depletion. Low 32.6 %, medium, 47.4 % and high 20 % (respectively in this area (Table 5).

Table 5: Extent of soil erosion and soil fertility in the study area

Variables	Description	Frequency	Percentage
Degree of Soil Erosion	Low	97	35.92
	Medium	123	45.56
	High	50	18.52
Total		**270**	**100**
Level of soil fertility	Low	88	32.6
	Medium	128	47.4
	High	54	20
Total		**270**	**100**

The perception of soil erosion is a serious problem was one of the major factors which influence the adoption of the SWC technologies. The study findings indicated the percentages of respondents who described the adopt such technique due to the problem of soil erosion. The results indicate that the majority of respondents (64.1%) adopt crop rotation due to the soil erosion problem, followed by those who adopt level bund (56.3%), agricultural inputs and FanyaJuu terrace with proportions of 53.3 % and 46.7% respectively

Table 6: Farmers who have experience on soil erosion and adoption of SWC strategies

Perception on Soil erosion	**CR**	**AI**	**FT**	**LB**
		% of respondents		
None	20.4	28.5	42.2	22.2
Experience S.E	64.1	53.3	46.7	56.3
Do not experience S.E	15.6	18.1	11.1	21.5
Total	100	100	100	100

*CR: crop rotation, AI: agricultural inputs, FT: Fanya Juu terrace, LB: Level Bund, SE: Soil Erosion

Perception of soil erosion as a hazard to agricultural production and sustainable agriculture is the most important determinant of effort at adoption of conservation measures. Forty-four percent of respondents stated to have the problem of soil erosion on their farms. And among them, 23% stated to have soil erosion as a serious problem while 21% said to have a problem of soil fertility depletion. In addition, it was found that soil erosion and soil fertility depletion is higher in hillside areas than in marshland. Surprisingly, it was found that all farmers (including those who reported to not have a problem of soil erosion) have adopted one or more SWC technology. Furthermore, the results showed a relationship ($p>.030$) between perception of the soil erosion problem and number of SWC technologies adopted in the area of the study. The implication is that farmers who feel that their farmlands are prone to soil erosion are more likely to adopt physical soil conservation measures than those who do not perceive the problem of soil erosion. This was proved by the findings of a study done by Tadesse & Belay (2004) in Ethiopia, which showed that farmers' perception of the soil erosion problem affects the adoption of soil conservation measures positively and significantly. Additionally, in relation to the findings of a research conducted by Simon et al., (2012) and Alufah*et al*., (2012) have shown that household size, perception of the soil erosion problem, training in soil erosion control, land ownership and access to institutional credit had significant effects on the adoption of SWC technologies.

4.2.6 Status of soil and Water Conservation Technologies in the study area

According to the research, it was found that crop rotation, agricultural inputs, terraces and ditches are the most used SWC technologies in the study area. The study results indicate that crop rotation is one of the most adopted by respondents (79.6%), followed by ditches (77.8%) and application of agricultural inputs (organic and mineral fertilizers) as well as radical terraces with proportions of 71.5% and 57.8% respectively (Figure 7). High adoption of crop rotation and agricultural inputs may be associated with the fact that is a simple technique and as well as availability of seeds through governmental support while ditches are the technique that are very easy to implement even at the household level. But on the other hand, radical terraces require much means, including financial, technical and labor means. Moreover, FanyaJuu terraces are new technologies that are being implemented in the study area.

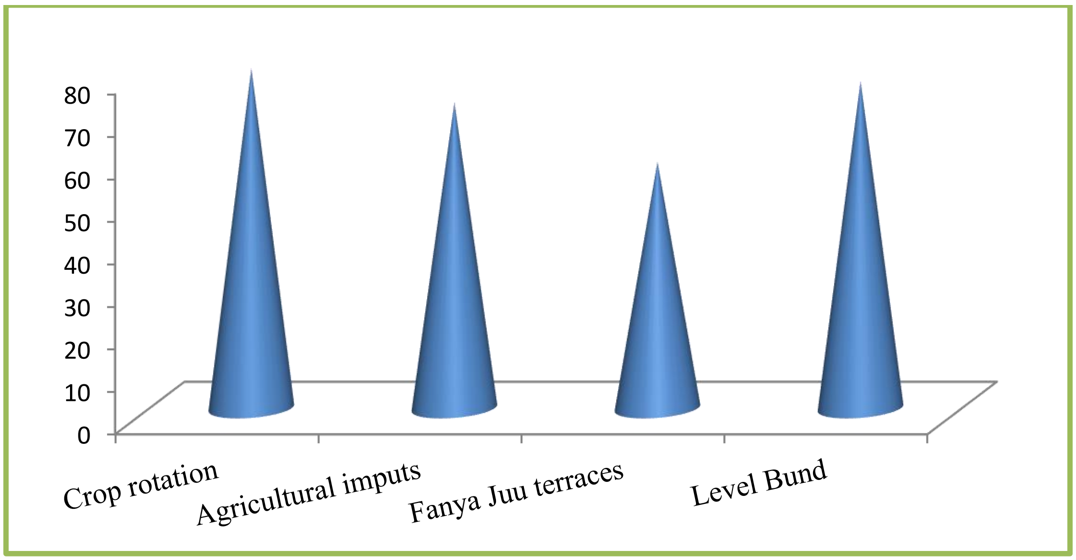


Figure 7: The most adopted SWC technologies in the study area (Field Survey, 2019)

On the other hand, the research findings indicate that the least SWC technologies are rainwater harvesting, grass strip, forest/ tree planting and Agroforestry. The results show that tree planting is one of the most adopted in the least used techniques (23.3%), followed by Agroforestry (19.63), grass strip and rainwater harvesting with proportions of 8.52% and 0.74% respectively (Figure 8).

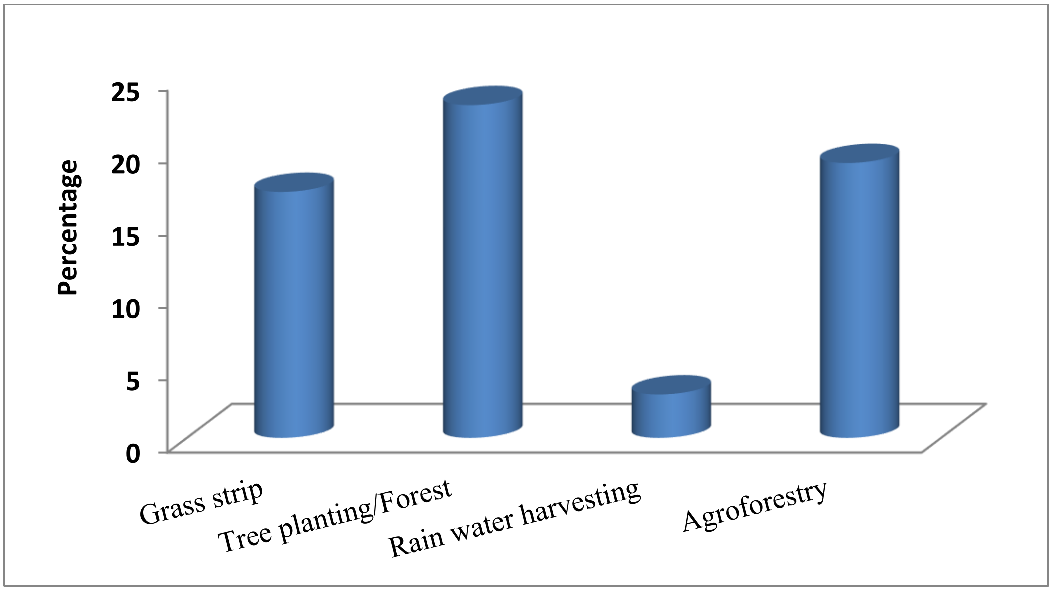


Figure 8: The least used SWC technologies in the study area

4.3 FACTORS CONTRIBUTING TO THE ADOPTION OF SWC TECHNOLOGIES

The study was identified the most used SWC technologies in the area. Identifying the factors contributing to the adoption of these techniques was also important. Therefore, this part describes the main factors contributing to the adoption of these SWC technologies. Throughout the study, respondents were asked to mention the key factors contributing to the adoption of these SWC technologies.

4.3.1. Farm size

The study findings indicate that the majority of the respondents (34.44 %) have farms with size less than 0.3 hectares. Farm size may influence adoption of SWC technologies directly or indirectly and vary from household to household. The results of study showed that adoption of SWC techniques is more frequent in farms with size less than two hectares than those with size greater or equal to two hectares (Table 7).

Table 7: Farm size and SWC technologies

Farm Size	**CR**	**AI**	**FT** **% of respondents**	**LB**
None	20.4	28.5	42.2	22.2
< 2 ha	66.6	58.9	48.9	68.5
≥ 2 ha	13.0	12.6	8.9	9.3
Total	100	100	100	100

*CR: crop rotation, AI: agricultural inputs, FT: FanyaJuu terrace, LB: Level Bund

The chi-square results indicated that at significant level of 0.05 farm size has a relationship ($p>0.003$) with the number of SWC technologies adopted in the area. This relationship may be explained by the fact that smaller farms are associated with land shortage and insufficient wealth which make worse the problem or impacts of soil erosion in their farms. This can therefore be expected to increase the probability of investment in soil conservation measures.

This association is similar to the findings of various studies. For example the study findings of Tadesse& Belay (2004). stated that farm size has a positive and significant influence on the farmers‟ decision to adopt physical soil conservation measures. The same as the findings of a study carried out inNigeria by (Amanze*et al*., (2010). proved that the output of the crop, level of education, farm size and price of fertilizer were important factors influencing farmers‟ use of fertilizer in arable crop production and also farm size were shown generally to have a positive impact on a household's decision to adopt and use a new technology such as fertilizer. Additionally, the studies done by Mulugeta (2000), Tadesse& Belay (2004) and Yishak (2005) indicated a positive relationship between farm size and adoption. Farm size and number of plots owned have a positive influence on the adoption of SWC practices. But, on the other hand, the findings of studies carried out in Cameroun and Ethiopia by Gockowski & Ndoumbe (2004) and Degnet, *et al*., (2001) revealed that there is negative relationship between farm size and adoption of mono-crop horticulture as well as between farm size and adoption of high yielding maize varieties.

4.3.2. Livestock rearing

The study results showed that 95.6% have at least one livestock while 4.4% have no livestock. It was also revealed that respondents who have at least one livestock have adopted at least one SWC technology (Table 8).

Table 8: Influence of livestock rearing on adoption of SWC technologies

Livestock rearing	**CR**	**AI**	**FT**	**LB**
			% of respondents	
None	20.4	28.5	42.2	22.2
± one livestock	77.4	68.1	56.3	74.1
No livestock	2.2	3.3	1.5	3.7
Total	100	100	100	100

*CR: crop rotation, AI: agricultural inputs, FT: FanyaJuu terrace, LB: Level Bund

It was found that having livestock is an important asset that could influence adoption of SWC technologies in one way or another. This could be explained by the fact that most respondents reported a shortage of feed for their livestock, especially during the dry season. Therefore, they adopt different SWC technologies in order to get sufficient fodder and water for their domestic animals. Statistically, the chi-square results indicate that there is no relationship ($p<0.341$) between raising livestock and the number of SWC technologies adopted in the study area. This is similar to the findings of the study done in Ethiopia by (Derajew*et al*., (2013) indicated that distance of the plot from residence, livestock holding and the fertility of the farm plot affect negatively and significantly farmers' conservation decision and the extent of use of improved soil conservation technologies**.** This affects soil conservation positively. Furthermore, this is was also proved by the findings of Tesfaye (2003) indicating that land size, livestock ownership, family size, risk perception, land tenure on non-arable lands, labor organization, characteristics of technology, indigenous institution and physical factors are significant determinants of SWC.

4.3.3. Crop yield

Respondents reported crop yield as a major factor influencing the adoption of SWC technologies. The study findings indicate that the majority of respondents (71.1%) reported to adopt crop rotation due to the need of increasing crop yield in their farms, followed by those who adopt level bund with a proportion of 69.6%, and then followed by 65.2% and 52.2% for those who adopt agricultural inputs and Fanya Juu terrace respectively (Table 9).

Table 9: Influence of crop yield on adoption of SWC technologies

Crop yield	**CR**	**AI**	**FT**	**LB**
			% of respondents	
None	20.4	28.5	42.2	22.2
expected	71.1	65.2	52.2	69.6
Not expected	8.5	6.3	5.6	8.1
Total	100	100	100	100

*CR: crop rotation, AI: agricultural inputs, FT: FanyaJuu terrace, LB: Level Bund

During the study, crop yield was identified as one of the factors contributing to the adoption of SWC technologies. Many farmers in the region were facing declining of crop yields due to high soil erosion, which in turn lead to soil fertility depletion. Thus, the decline in crop yield is attributed to land degradation, which is a result of various factors, among others soil erosion, nutrient mining, and the inability of smallholder farmers to adopt technologies that enhance soil conservation and soil fertility (Bojö, 1996; Mbaga-Semgalawe & Folmer, 2000).

According to the chi square results, the study results showed that farmers‟ perceptions on low crop yield has a relationship ($p>0.020$) with the adoption of SWC technologies in the study area. This is similar to the findings of a study done by Amanze*et al*., (2010) where they proved that the output of the crop, level of education, farm size and price of fertilizer were important factors influencing farmers‟ use of fertilizer in arable crop production.

4.3.4. Inputs

The study results show that 55.2% of respondents reported to adopt crop rotation due to the subsidizing of agricultural inputs while 51.5% using agricultural inputs (manure and fertilizers) due to the fact that they get subside of organic and mineral fertilizers at low cost (Table 10).

Table 10: Influence of input (support) on adoption of SWC technologies

Inputs	**CR**	**AI**	**FT**	**LB**
			% of respondents	
None	20.4	28.5	42.2	22.2
yes	55.2	51.5	34.1	47.4
No	24.4	20.0	23.7	30.4
Total	100	100	100	100

*CR: crop rotation, AI: agricultural inputs, FT: Fanya Juu terrace, LB: Level Bund

The study results indicate that most of farmers adopt crop rotation and agricultural inputs due to the subsidies of organic and mineral fertilizers as well as improved seeds. The subsidizing of organic and mineral fertilizers as well as improved seeds may influence the adoption of SWC technologies directly or indirectly. Statistically, the chi-square results showed that having access to support (inputs) is associated ($p>0.000$) with number of adopted SWC technologies in the study area. This is similar to the study done by Tewodros & Melesse (2010) where their findings revealed that households with large farm size, better socioeconomic status, endowed with labor, access to institutional supports and a number of monthly contacts with development agents were more likely to adopt and this is confirmed by a positive elasticity.

4.3.5. Knowledge and their Source (access to extension services) and Farmers' Experience

Extension plays a great role in promoting SWC technologies. During the interview, it was clear that farmers in the area got assistance from extension services. The access to the extension services may influence the adoption of SWC technologies in one way or another. The study found that most respondents have reported to adopt SWC technologies due to the access to extension services. The results also indicated that due to the access to extension services; 76.7% and 76.6% of respondents adopt bund and crop rotation respectively, while 70.7% and 57.8% farmers adopt the application of agricultural inputs (organic and mineral fertilizers) and terraces respectively (Table 11).

According to the respondents' experience, the results indicated that the majority of farmers adopted SWC technologies below fifteen years, while only few of them adopted SWC technologies more than sixteen years (Table 11).

Table 11: Knowledge from extension services and SWC technologies

Extension service	**CR**	**AI**	**FT**	**LB**
			% of respondents	
None	20.4	28.5	42.2	22.2
Have knowledge	76.6	70.7	57.8	76.7
Do not have knowledge	0.0	0.7	0.0	1.1
Total	100	100	100	100

Respondents' Experience	**CR**	**AI**	**FT**	**LB**
		% of respondents		
None	20.4	28.5	42.2	22.2
Below 15 years	57.0	37.8	57.0	56.7
More than 16 years	22.6	33.7	0.7	21.1
Total	100	100	100	100

*CR: crop rotation, AI: agricultural inputs, FT: FanyaJuu terrace, LB: Level Bund

The results from farmers and key informant interview indicate that farmers get assistance provided by extension services and this assistance has a great role in adoption of SWC technologies.

The chi square results indicated that there is no relationship ($p<0.192$) between access to the extension service and the number of SWC technologies adopted in the study area. Furthermore, the statistical results showed that there is a connection ($p>0.000$) between farmers‟ experience and a number of SWC technologies adopted. To the Contrary, findings of a study carried out in Burkina Faso by Basga (1992) proved that governmental extension services exhibit positive correlation coefficients for both the traditional and new soil conservation practices. And moreover, according to the findings from the study done by Derajew*et al.*, (2013) pointed out that the educational level of the household head; extension contact; and slope of the plot positively and significantly affect farmers' conservation decision and the extent of use of improved soil conservation technologies. Furthermore, the findings of Senait (2005) showed that land ownership type, distance of the farm plot from homestead, resource availability and contact with extension agents were found to be the most important factors affecting choice of land management practices such as the use of commercial fertilizer, manure, stone/soil bonds or a combination of them.

This is similar to the findings of Adeola (2010) discovered that education; contact with extension agents, farming experience and farm size significantly influenced the adoption of soil conservation measures among farmers. Further, the finding of Belay (2014) also asserted that farmers have experiences of one or more of the soil and water conservation practices.

4.3.6. High slope

High slope was identified as one of the last factors affecting the adoption of SWC strategies in the area. The research findings indicate that slope situation affects the adoption of crop rotation, agricultural inputs, Fanya Juu terrace and level bund (Table 12). In fact, the area of the study is characterized by high rainfall and some hills which facilitate high runoff, which in turn cause the excessive soil loss through soil erosion.

Table 12: Influence of slope on adoption of SWC strategies

High Slope	CR	AI	FT	LB
			% of respondents	
None	20.4	28.5	42.2	22.2
Adopt due to high slope	17.4	15.9	3.7	4.8
Do not adopt due to high slope	62.2	55.6	54.1	73.0
Total	100	100	100	100

*CR: crop rotation, AI: agricultural inputs, FT: FanyaJuu terrace, LB: Level Bund, SE: Soil Erosion

The results indicate that there is a connection ($p>0.000$) between the high slope and number of SWC technologies adopted. The implication is that farmers who cultivate in hillside areas tend to adopt more diverse SWC technologies than those who do not cultivate the land which is susceptible to excessive soil erosion. This was proved by many authors, including Ervin & Ervin (1982), Gould et al., (1989), Paulos (2002) and Wagayehu (2003) their findings revealed that the slope category of the plot has been found to be positively affecting the farmer's decision to invest in conservation technologies.

4.4. EXTENT OF USING OR ADOPTION OF SWC STRATEGIES

Table 13 shows the extent of farmers' adoption of SWC technologies. The adoption score indicates the number of the four SWC technologies that farmers have adopted, and the frequency with the corresponding percentage refers to the number of farmers who have adopted the conservation practices. One hundred and thirteen farmers (41.9%) have adopted between one and two SWC technologies, and one hundred and fifty-seven farmers (58.2%) have adopted between three and four SWC technologies. In this group, one hundred and two farmers (37.8%) have adopted all the four SWC technologies.

Table 13: The extent of the adoption of SWC technologies

Number of technologies adopted	Frequency	Percentage
1	25	9.3
2	88	32.6
3	55	20.4
4	102	37.8
Total	**270**	**100**

The reason behind the adoption of one or more SWC technology is that the study area is characterized by excessive rainfall which causes much soil loss and runoff. This could also be explained by the program launched by the Government of Ethiopia to the land that could be more protected by various technologies through farmers‟ participation approach. The program is called Sustainable Land Management (SLM).

Figures from Table 14 indicate that overall, farmers in the study area used more agronomic measures (Crop rotation and agricultural inputs) than those who adopted physical measures SWC technologies (FanyaJuu terraces and Level Bund). The results indicated that 90.7% of respondents adopted traditional SWC practices while 78.1% use improved SWC technologies.

Table 14: Agronomic and Physical measures

Technologies adopted	Frequency	Percentage
Agronomic	245	90.7
Physical	211	78.1

The high adoption of agronomic measures could be explained by the availability of improved seeds and fertilizers through governmental subsidies and the fact that they are easy and simple to apply. While on the other hand, physical measures are much higher dependent on much labor as well as financial means.

According to the Table 15 among the SWC technologies, crop rotation, ditches and agricultural inputs were the most used technologies, amongst farmers with proportions of 79.6%, 77.8% and 71.5% respectively. It can be seen that farmers have poorly adopted radical terraces (57.8%).

Table 15: Distribution of the adopted SWC technologies in the study area

Adoption score	Frequency	Percentage
Crop rotation	215	79.6
Level Bund	210	77.8
Agricultural inputs	193	71.5
FanyaJuu terraces	156	57.8

The reason which would be behind, this adoption is that; crop rotation, level bund and agricultural inputs are easier and cheaper SWC technologies to be implemented. And they can be done by household itself while fanya juu terraces are required much labor and inputs and also households alone cannot make fanya juu terraces without external financial means or Governmental supports. Reason for less adoption of fanya juu terraces technology in the study is that the technology is still new in the study area and was adopted by very few numbers of farmers.

Crop rotation is the first most adopted technologies in the study area and it is also the most traditional practices used for improving soil fertility and conserving the soils. The major crop rotation practiced by farmers in the area is maize and beans. The reason behind, this high adoption is due to the fact that it is a simple and easy technology to apply. This technology plays an important role in improving soil productivity, soil cover, structure and fertility and thus enables soil erosion control.

The second technology is Level bund which used in the study area for protecting soil from erosion by draining excessive water; this facilitates the infiltration of water into the soil easily. The technology is very simple and easy to be established by any person in the study area. This was explained by Yohannes (1999) by stating that the potential of this technology is that it demands less labor, and being flexible, it can be easily established by any farmer. Additionally, it is practicable where the slope of the land is very high, stony catchment and high quantity of water.

The third technology is agricultural inputs (organic and chemical fertilizers) are also used in the area for the achievement of increased agricultural production and productivity and thus are considered as a practice susceptible for soil fertility management (Table 15). Based on interview with households and key informants, farmers have increased the amount of agricultural inputs, especially applied manure because of the high price of inorganic fertilizers and also due to the accessibility of trainings of compost making as well livestock availability.

Lastly, fanyajuu terraces are less adopted by comparison with those three other technologies. This could be explained by the fact that fanyajuu terraces are much more labor intensive, require technical advisory input and in addition is still new technology introduced in the study area by comparison with other previous technologies.

The study found out that fanyajuu terraces are greatly used for reducing high slope in order to control high runoff and minimize soil erosion at the same time increasing agricultural productivity; they conserve soil moisture and fertility and facilitate cropping operations as well as promote intensive land use and permanent agriculture on the slope. Bizoza&Graaff (2012) showed that Fanyajuu/radical terraces in the highlands of Ethiopia are only financially viable when the opportunity cost of labor and manure are below the local market price levels and when an agriculture area on these radical terraces can be substantially intensified.

4.5. BENEFITS OF SWC STRATEGIES TO LIVELIHOODS AND ADAPTATION OF SMALLHOLDERS FARMERS

This section analyzed the effectiveness of SWC activities in terms of the livelihoods of smallholder farmers and role in adapting to climate change impacts in the study area. Vulnerability context, access to livelihood assets, institutions, policy and process and livelihood strategies were considered to assess the role of SWC practices to livelihoods and adaptation to climate change.

Farmers were asked to mention the effects or benefits of SWC technologies through household questionnaires. The most of the respondents (70.4%) considered increase/improve crop yield to be a major benefit, while 55.6% indicated that SWC technologies improves soil fertility. 45.9% stated that adoption of SWC technologies has reduced soil erosion/runoff in their farms as well as 33.7% said to play a great role in fodder production, especially fanyajuu terraces and others, including improved water quantity and quality, access to credit and savings as well as increase of income (Table 16).

Table 16: Benefits of SWC technologies in the study area

Benefits	Frequency	Percentage
Improved agricultural productivity	190	70.4
Improved soil fertility	150	55.6
Reduced soil erosion/runoff	147	54.4
Increased vegetation cover/ fodder production	91	33.7
Others	126	46.7

However, the use of crop rotation and agricultural inputs play an important role in improving soil properties especially soil structure and chemical properties. In fact, a great number of respondents considered an improvement of crop yield as major benefits of SWC technologies. This is associated with the fact that most of the respondents as well as 98% of all peoples in Benishangul Gumuz Region depend on agricultural production as their major source of living.

Further, according to the results from households' and key informant interviews, they indicated that adoption of SWC technologies has reduced soil erosion by controlling runoff in hillsides and improve soil fertility. In fact, severe soil erosion has led to the loss of soil fertility which now is improving due to the adoption of the SWC technologies. Benishangul Gumuz Region as well as study area is characterized by high excessive rainfall which makes worse the situation of the soil erosion problem. Respondents also mentioned the availability of fodder as benefit from adoption of SWC technologies. Actually, due to the fire and over grazing used in the study area, people were facing a shortage of forage for their livestock mainly during the dry season. The findings of a study by Demeke (2003) also showed that farm size and perception of benefit from conservation measures positively and significantly affect the farmers' decision to adopt conservation structure.

SonkaKebele is a gently sloping (0-4%) area with trees, grasses and shrubs and the devastating soil degradation agents are sheet erosion of mainly sandy clay loam soils. Present land uses are predominantly arable farming (mainly sorghum, maize and beans) and livestock production (SLMP 2016). Localized soil and water conservation practices are largely the use of crop rotation and agricultural inputs which were experienced as highly between 3 and 6 years. However, fanyajuu terraces and level bunds were perceived as less need techniques on the area's level topography

Mender-49 Kebele is located on a steeply sloping (20-22%) ground dominated by livestock production and arable farming of largely sorghum. The soils are predominantly silty clay loam textured with few trees and grass vegetation (SLMP 2016). High erosion intensities due to site elevation are seasonally curtailed by application of durably strong barriers. The conservation techniques were Hill side fanya juu terraces, level bund and agricultural input applications over a period of between 2 and 10 years. Crop rotation was not used, possibly due to its perceived low impacts under the excessive erosion devastations. Field observation showed that considerable soil and water conservation were conserved against the menacing rill and gully erosion in the area.

Mender-46 Kebele is riverine area on a moderately slopping (8-10%) field with considerable trees interposed by shrubs. The soil is mainly of sandy loam textures largely utilized for orchards.

Gully landslides prove the most serious soil loss agent devastating the area (SLMP 2016). The conservation practices investigated recorded moderate applicable level bund technique is conservation practices in place conserved moisture retained the farm and reduced gully spreads with a contribution on sustainable crop production activities in the area.

4.5.1. Vulnerability context

According to the farmers, there are many extreme events like heavy rainfall and excessive soil erosion that damage farmers' livelihoods. These trends are not favorable and lead to the adaptation and/or adoption of new SWC technologies. Thus, 74% of farmers described to adopt SWC technologies due to soil erosion problem which is mainly associated with heavy rainfall in the study area. While 28.1% described that they adopt different SWC technologies because of weather changes. It was also noted that 5.9% and 1.8% were using SWC technologies because of the selected seeds which are able to adapt to the changes in weather and also to the pests respectively. While, on the other hand 3.3% and 1.1% are using SWC technologies due to the land shortage as well as fluctuation occur in prices at market level (Table 17). Many experts would expect this trend due to the rapid population growth and strong overexploitation of land resources.

Table 17: Trends found in the study area

Trends	Frequency	Percentage
Soil erosion	200	74.1
Weather changes	76	28.1
Selected crops	16	5.9
Shortage of land	9	3.3
Pests	5	1.8
Changes in market prices	3	1.1

4.5.2. Livelihood Assets

The livelihood assets of the study area were distinguished into five different capitals: human, social, natural, physical and the financial capital.

Table 18: The five different capitals and used indicators

Human Capital	Age, HH size, Education and knowledge
Social Capital	Member of farmers' cooperatives
Natural Capital	Access to land, farm size
Physical Capital	Farm equipment
Financial Capital	Access to credit and saving, insurance, Livestock rearing

i. Human capital:

The research findings that the majority of respondents are aged between 21 and 40 years (46.3%) followed by those who are in the range of 41 to 60 years old (37.4%) while those who are below or equal to 20 years and the one who are aged over or equal to 61 altogether are 16.3% (Table 18 and Table 19). Regarding their education level, the results showed that most of them have primary education (73.75%) followed by those who did not attend any schools (20.74%) while those with education beyond primary are 5.55% (Table 19 and Table 20).

Additionally, the results show that households with members ranging from one to three persons are 20.7%, households with members ranging from four to six persons are 75.2%, family size ranging from seven to nine are 4.1% (Table 19 and table 20). The study findings, also indicated that farmers who have access to trainings and extension services as their source of knowledge are 53% and 98.89%, respectively, and only 2.2% said to get knowledge of SWC technologies through knowledge dissemination (from parents or eldest to children) (Table 21).

Table 19: Human Capital

Human Capital	**Frequency**	**Percentage**
Age	≤ 40	129
	≥ 41	141
Education	Primary	199
	Beyond primary	15
HH size	≤ 3	56
	≥ 4	214
Source of Knowledge	Extension service	267
	Trainings	143
	Others	6

Statistical results showed that there is no connection ($p<0.179$, $p<0.139$ and $p<.090$ respectively) between age, household size and education and number of SWC technologies adopted and also the results indicate that access to extension service and dissemination of knowledge have no relationship ($p<0.192$ and $p<0.318$ respectively) with number of adopted SWC technologies, but on the other hand, the chi square results ($p>0.000$) also indicated that access to trainings has a relationship with number of SWC technologies adopted in the study area. This is contrary to the findings of a study carried out in Nigeria by Amanze*et al*., (2010)' use of fertilizer in arable crop production and also farm size were shown generally to have a positive impact on a household's decision to adopt and use a new technology such. But on the other hand findings of Simon *et al*., (2012) and Alufah*et al*., (2012) showed that the household size, perception of the soil erosion problem, training in soil erosion control, land ownership and access to institutional credit had significant effects on the adoption of SWC technologies.

ii. Natural capital

All respondents have their own land, either for living or cultivating, and the most cultivated land is found near their living homes and the majority (86.7%) of farmers has land with the size ranging below 2 hectares, while 13.3% have land with size greater than or equal to two hectares. Statistical results ($p>0.003$) showed that the size of the farm has a connection with a number of SWC technologies adopted. However, most of the people in the study area rely on the environment for their livelihoods. This association is similar to the findings of Tadesse& Belay (2004) stated that farm size has a positive and significant influence on the farmers" decision to adopt physical soil conservation measures.

iii. Social capital

As indicated by the household interview and key informant results, it was found that 73% of farmers are in different cooperatives, and each cooperative is formed by 20 to 30 people. In these cooperatives wherever farmers get access to different supports including trainings and credits for agricultural investments.

Table 20: Social Capital

Social Capital	Frequency	Percentage
Member of cooperative	197	73
None	73	27

The results of the Chi-square ($p>0.000$) indicated that being a member of a cooperative have a relationship with the number of SWC technologies adopted the area. Social assets are about unity and community actions. Nowadays, in study area, many farmers are operating in cooperatives. Thus, the study findings indicate that 73% of respondents are in different cooperatives, related to agricultural activities (farming and livestock) and women's cooperatives. These cooperatives represent a form of social capital that provides value to individual households. For example, in Bambasi District, there is always a community work at every last Friday of a month. The type of work is mainly based on environmental protection activities, including planting trees, creating radical terraces and waterways, etc. Strong social capital helps in allocating water resources among households and their farms in ways that are acceptable to community members and beneficial to the community as a whole. Furthermore, according to the statistical results, it was found that there is a connection between being a member of such cooperative and number of SWC technologies adopted.

iv. Financial capital

Many households have inadequate financial capital. The most source of financial capital is from raising livestock, farming activities (including crop production, forest, coffee) and credit from cooperatives. The study results revealed that 95.6% and 73% of farmers in the study area gets financial capital through raising livestock and cooperatives respectively (Table 21).

Table 21: Main source of Financial Capital

Financial Capital	Frequency	Percentage
Member of cooperative	197	73
Raising livestock	258	95.6

Cooperatives are main resources of access to financial capital in the study area. In these cooperatives wherever farmers get access to credit and savings through their contribution which is equal to fifty Ethiopian Birr (1.79$) per week.. However, the reasons behind these cooperatives are due to the fact that in Ethiopia there is a policy of helping people (smallholder farmers in general) through cooperatives. They get trainings and support through these cooperatives. Because of the inadequate financial means, farmers are unable to invest in new SWC technologies especially fanyajuu terraces. They wait intervention of Governmental support in terms of financial means or materials as well as trainings. Additionally, limited financial resources also prevent farmers accessing all of the complementary inputs required to maximize the productivity of land and water resources. Thus, livestock rearing has a great contribution to the increasing of farmers' income throughout the production of meat, milk, eggs as well as manure. According to the statistical results($p<0.341$), it was found that there is no relationship between livestock rearing with a number of SWC technologies adopted while on the other hand, there is an association between being a member of the cooperative ($p>0.000$) and number of SWC technologies adopted in the study area.

The findings of a study done by Derajew*et al*. (2013) indicated that distance of the plot from residence, livestock holding and the fertility of the farm plot affect negatively and significantly farmers' conservation decision and the extent of use of improved soil conservation technologies. But in addition, the findings of Tesfaye (2003) revealed that land size, livestock ownership, family size, risk perception, land tenure on non-arable lands, labor organization, characteristics of technology, indigenous institution and physical factors are significant determinants of SWC. Furthermore, the research findings of Simon *et al*., (2012) and Alufah*et al*., (2012) showed that household size, perception of the soil erosion problem, training in soil erosion control, land ownership and access to institutional credit had significant effects on the adoption of SWC technologies.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

As conclusion, the main purpose of the study was to investigate of the application Soil and Water conservation practices as its contribution to livelihood of smallholder farmers in Sonka kebele, Mender-49 and Mender 46, Bambasi District of Benishangul Gumuz Region, Ethiopia.

Four types of SWC technologies were identified in the area. The major factors contributing to their adoption were seen as; farm size, livestock rearing, crop yield, support, knowledge from extension services and experience, farmers' perception of soil erosion and steep slope. Soil and water conservation technologies appeared viable and relevant in conserving soil and water required for sustainable livelihood and as a means to adapt to ever increasing climate change in the study area. Even the techniques rated as not effective were likely due to their non-applications, other than the observed inefficiency of the technologies. Long term technologies practice was recorded as direct functions of the conservation structures established in the areas studied. And it was found that respondents were willing to adopt SWC technologies. It was found that at least one technology has been adopted. But it was also found that a combination of SWC technologies is preferred over the section of single technology. As a matter of fact, the adoption of these SWC technologies has made respondents feeling secure of their assets. Those include human, natural, physical, social and financial capitals. Furthermore, the study concluded that most of the participants were willing to conserve soil as a valuable resource and apply SWC technologies to increase resilience to climate changes through maximizing their benefits including improvement of agricultural productivity as well as soil fertility and same time reduced soil erosion. But the study expressed the need for the continuing supporting of the implementation. Further, it also brings to a close that conservation efforts should target areas where expected benefits are higher, especially on the steeper slopes, in order to encourage the use of the SWC technologies.

Heavy rainfall followed by severe soil erosion that results in gullies and loss of farmlands and productivity is the major climatic risk in the study area. Therefore, SWC technologies can improve the capacity of smallholders to reduce the impacts of such climatic changes as well as ensure the sustainability of crop production.

5.2. Recommendations

The specific recommendations of this study would enhance the practice of SWC activities to adapt to the changing climate by increasing resiliency and livelihoods in the area of the study in particular and in other region in general.

Recommendations to the policy makers Observed soil protecting and enriching practices should be extensively encouraged among farmer population to enable cheap soil conservation and fertilization as alternatives to the costly scarce mineral fertilizers.

- Promotion of soil and water conservation technologies as a tool to adapt the climate changes and enhance livelihoods by providing appropriate trainings on use dimensions and management to local communities.
- Developing proper strategies to make SWC practices more effective in increasing crop productivity, soil fertility, water resources, forage and financial resources. And also promoting greater involvement of NGOs in investment in SWC activities

- Promote the use of Agroforestry, forestry and water harvesting technologies in the study area by providing adequate training.

Recommendations for further research:

This study found that there were no researches done on Soil and Water Conservation practices in the study region. Hence, it recommends further research to work on the following areas:

- As climate change is one of the challenges farmers are facing, it's better to assess the contribution of SWC practices to the mitigation of climate change in the region.
- To assess the socioeconomic impact of fanyajuu terraces and level bund on women in the study area.
- A comparative study of investment in agricultural inputs and final agricultural productivity in SWC technologies.

REFERENCES

Adeleke, S., A.B. Kamara and Z. Brixiov. 2010.*Smallholder Agriculture in East Africa:Trends, Constraints and Opportunities.* Working Papers are available online. TUNIS,Tunisia: African Development Bank.

Adeola, R. 2010. *Influence of Socio-Economic Factors on the Adoption of Soil Conservation Measures in Ibadan/Ibarapa Agricultural Zone of Oyo State*.Ogbomoso Oyo state, Nigeria: Department of Agricultural Economics and Extension.

Anderson, D. M. 1984.*Depression, dust bowl, demography, and drought: The colonial state and soil conservation in East Africa during the 1930s.* African Affairs, 83 (332), 321¬43.

Bai, Z., D. Dent, L. Olsson and M.Schaepman. 2008..*Proxy global assessment of land degradation*. Soil Use and Management, 24:223–234.

Bandara, DGVL.; S.Thiruchelvam. 2008. *Factors Affecting the choice of soil conservation practices adopted by Potato Farmers in NuwaraFliya District, Sri Lanka.* Tropical Agricultural Research and Extension 52.

Basga, E. D. 1992. *The adoption of soil conservation practices in Burkina Faso: the role of indigenous knowledge, social structure and institutional support.* Iowa State University.

Batjes, N. 2001. *Options for increasing Carbon Sequestration in West African Soils. An Explanatory Study with Special Focus on Senegal.* 12: 131-142.98

Beinroth, F. E. 1994. *Land related stresses in agroecosystems.* In J. K. S.M. Virmani, *Stressed Ecosystems and Sustainable Agriculture, eds.* New Delhi: Oxford and IBH.

Bizimana, Jean. 2011. *Economic Impact Analysis of Radical Terracing Project. Case study Cyabingo Sector in GakenkeDistrict.Faculty of Agricultural engineering and Environmental Sciences, Department of Soil and Water Management* Higher Institute of Agriculture and Animal Husbandry.

Bizoza, A.R. & J.de.Graaff. 2012.*Financil cost-benefit analysis of bench terraces in Rwanda.* Journal of Land Degradation and Development. Vol.23 103-115.

Bojö, J. 1996. *The cost of land degradation in Sub-Saharan Africa.*Ecological Economics, 16: 161-73.

CalatravaLeyva, J.; J.A.Franco Martínez and M.C.González Roa. 2007..*Analysis of the adoption of soil conservation practices in olive groves: the case of mountainous areas insouthern Spain.* Spanish Journal of Agricultural Research 5(3), 249-258.

Carney, D. 1998.*Implementing the Sustainable Rural Livelihoods Approach in D. Carney (ed) Sustainable Rural Livelihoods: What contributions can we make?* .London: DFID.

Chambers, R., and G. Conway.1992.*Sustainable Rural Livelihoods: Practical Concepts for the 21st Century', Discussion Paper 296.* Brighton, UK: Institute of Development Studies.99

Chelemu, K.; P. Nindi. 199.*Conservation Tillage for Soil and Water Conservation Using Draft Power in Zambia. Meeting the Challenges of Animal Traction.A Resource Book of the Animal Traction Network for Eastern and Southern Africa.*London Intermediate Technology Publications

Clay, D. C., and L.A.Lewis. 1996. *Land use, Soil Loss, and Sustainable Agriculture in Rwanda. Human Ecology:* An Interdisciplinary Journal, 18 (2) (1990), 147-161.

Clay, D., and T.Reardon. 1994.*Determinants of Conservation Investments by Rwandan Farm*

*Households.IAAE Occasional Paper No. 7.Contributed Paper for the 22nd Congress of the International Association of Agricultural Economics, August 1994.*The 22nd Congress of the International Association of Agricultural Economics, August 199, No. 7.

Dan, G. (2006). *Agriculture, rural areas and farmers in China.*Beijing, China: China Intercontinental Press.

Degnet, A., K.Belay, and W.Aregay.2001. *Adoption of high-yielding maize varieties in Jimma Zone: Evidence from farmers' level data in Ethiopia.* Journal of Agricultural Economics:5 (1&2), 41-62.

Demeke, A. B. 2003. *Factors Influencing the Adoption of Soil Conservation Practices in Northwestern Ethiopia.* Institute of Rural Development, University of Goettingen Dependent on .2009. Intermediate Results Dissemination Workshop February 5-6, 2009.
Organized by IWMI Subregional Office for East Africa and Nile Basin, Addis Ababa, Ethiopia. Compiled by Seleshi B. Awulachew, TekluErkossa, Vladimir Smakhtin and AshraFernando170-180Addis AbabaIWMI.

Derajew, F.,F., Bekabil. And B.Wagayehu. 2013.*Determinants of the Use of Soil Conservation Technologies by Smallholder Farmers: The Case of HuletEjuEnesie District, East Gojjam Zone, Ethiopia.* Asian Journal of Agriculture and Food Sciences, Volume 01, Issue 04.

DFID.1999. *Sustainable Livelihoods Guidance Sheets.*London: Department for International Development.

DFID.2000. *Sustainable Livelihoods – building on strengths.*London, UK: Department for International Development.

Dixon, J., A.Tanyeri-Abur And H.Wattenbach. 2003.*Context and Framework for Approaches to Assessing the Impact of Globalization on Smallholders.* In *In Dixon J., K. Taniguchi and H. Wattenbach edited, Approaches to Assessing the of Globalization on African Smallholders: Household and Village Economy Modeling, Proceedings of Working Session Globalization and the African Smallholder Study.* Rome, Italy:

Ellis, F. 2000.*Rural Livelihoods and Diversity in Developing Countries.*Oxford : Oxford University Press.

Ervin, C.and E.Ervin. 1982.*Factors affecting the use of soil conservation practices: Hypotheses, evidence, and policy implications.*Land Economics 58 (3): 277- 92.

Eswaran, H., R.Lal and F.Reich. 2001.*Land degradation: An overview.* Retrieved November 6, 2014, from Natural Resources Conservation Service Soils. United States Department of Agriculture (USDA): http://www.nrcs.usda.gov

FAO.2006b. *Socio-Economic & Livelihood Analysis in Investment Planning.*Rome, Italy: FAO.

FAO. 2008. *The State of Food and Agriculture (SOFA) 2008-Biofuels: prospects, risks and opportunities.* Rome: Food and Agriculture Organization of the United Nations.

FAO.2011. *Farming Systems Report. Synthesis of the Country Reports at the level of the Nile Basin.*Rome: Food and Agriculture Organization of the United Nations.

Gebreselassie Yihenew.;Amdemariam Tadele.; Haile Mitiku.; Yamoah Charles. 2009. *Lessons from Upstream Soil Conservation Measures to Mitigate Soil Erosion and its Impact on Upstream and Downstream Users of the Nile River. In Improved Water and Land Management in the Ethiopian Highlands:* Its Impact on Downstream Stakeholders

Gould, B., W.Saupe and R.Klemm. 1989. Conservation tillage: *The role of farm and operator characteristics and the perception of soil erosion*. Land Economics 67 (2): 167-82.

Gov,R. 2009. *Rwanda State of Environment and Outlook Report*. Retrieved November 4, 2014, from http://www.rema.gov.rw: http://www.rema.gov.rw/soe/chap3.php

Gov.E. 2013. *Economic Development and Poverty Reduction Strategy 2013-2018. Shaping Our Development.*Adiss Ababa: The Federal Democratic Republic of Ethiopia.

Haggblade, S., G.Tembo and C.Donovan. 2004. *Household Level Financial Incentives to Adoption of Conservation Agricultural Technologies in Africa.*East Lansing, Michigan State University (FSRP).

Hill J, J.Megier and W.Mehl. 1995. *Land degradation, soil erosion and desertification monitoring in Mediterranean ecosystems.* Remote Sensing Reviews, 12 (1-2): 107-130.

Houghton, R. 1994. *The worldwide extent of land use change.* Bioscience, 44:305 -313. http://www.tradeoffs.montana.edu/pdf: http://www.tradeoffs.montana.edu/pdf

IAASTD.2009. *Summary for Decision Makers of the Global Report.*Retrieved November 11,2014, from http://www.agassessment.org

IFAD.1992. *Soil and Water Conservation in Sub-Saharan Africa. Towards sustainable production by the rural poor* Amsterdam.

IFAD. 2011. *Rural groups and the commercialization of smallholder farming:Targeting and development strategies (draft). (Issues and perspectives from a review of IOE evaluation reports and recent IFAD country strategies and project designs.).*Rome: International Fund for Agricultural Development.

IFAD. 2014. *Investing in rural people in Rwanda.* Rome, Italy: International Fund for Agricultural Development.

IPCC. 2007. *Contribution of Working Group Ii to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007*. Cambridge, UK.

Keyser, J., and M.H.Mwanza. 1996.*Conservation Tillage.*Lusaka, Zambia: The Institute of African Studies, University of Zambia.

Krantz, L. 2001. *The sustainable Livelihood Approach to poverty reduction: An introduction.* Swedish International Development Cooperation Agency (SIDA). Division for Policy and Socio-Economic Analysis.

Lewis, L. A., D.C.Clay and Y.M.Dejaegher. 1988. *Soil loss, agriculture, and conservation in Rwanda: Toward sound strategies for soil management.* Journal of Soil and water Conservation.The science and art of natural resource management for sustainability. Soil and water conservation society. Vol. 43 no. 418-421.

Mbaga-Semgalawe, Z. and H.Folmer. 2000 .*Household adoption behavior of improved soil conservation: The case of the North Pare and West Usambara Mountains of Tanzania*. Land use policy 17: 321-36.

MINAGRI. 2010. *Evaluation Report on Crop Intensification Program: International Center for Soil Fertility and Agricultural Development.* Kigali, Rwanda: MINAGRI. MINAGRI. 2013. *Agriculture Sector Investment Plan 2009 – 2012*. Kigali, Rwanda: Government of Rwanda.

MINECOFIN.2013. *Economic Development and Poverty Reduction Strategy II.*Kigali: The Republic of Rwanda.

MINITERE.2004. *National Land Policy*.Kigali, Rwanda: Rwanda Government.

Monimart, M. 1989. *Femmes du Sahel. La desertification au quotidienne. Club du Sahel.*Paris.

Morse, S., McNamara, N., & M.Acholo. 2009.*Sustainable Livelihood Approach: A critical* *analysis of theory and practice in Geographical Paper No. 189.* University of Reading, UK.

Mugenda, O. M. and AG.Mugenda.2003. *Research Methods, Qualitative and Quantitative Approaches*.

Mulenga, N. 2003. *Conservation Farming in Zambia.*LusakaTechnical Services Branch, MACO.

Nabhan, H., A.M Mashali and A.R Mermut. 1999.*Integrated Soil Management for Sustainable Agriculture and Food Security in Southern and East Africa.*Rome: Food and Agriculture Organization of the United Nations.

Natalie, S. 2008. *Reasons for adoption and spread of conservation agriculture among smallscale farmers Laikipia and Meru District, Kenya. Diplomarbeit der PhilosophischnaturwissenschaftlichenFakultät der Universität Bern vorgelegtvon:*University of Bern: Center for Development and Environment.

NISR.2012. *Fourth Population and Housing Census, Ethiopia,* Addis Ababa. The Federal Democratic Republic of Ethiopia.

NISR.2014. *Seasonal Agricultural Survey*.Kigali, Rwanda: The National Institute of Statistics of Rwanda.

Oldman, L. R. 1991. *World Map of the Status of Human-Induced soil Degradation: An Explination Note.* Wageningen, The Netherlands and Nairobi, Kenya: International Center and United Nations EnvirobnmentalProgramme.

Paulos, A. 2002. *Determinants of Farmers" Willingness to Participate in Soil Conservation Practices in the Highlands of Bale: The case of Dinsho Farming system area.* Hamalaya, Ethiopia: Alemaya University.

Pla, I. 2000. *Hydrological approach to soil and water conservation.*In: Keynotes-ESSC Third International Congress, (pp. 45-69). Valencia, Spain.

Place, F. and P.Hazell. 1993.*Productivity effects of indigenous land tenure systems in sub Saharan Africa.*American Journal of Agricultural Economics 75, 10-19.

REMA.2009. *Rwanda State of Environment and Outlook.*Kigali, Rwanda: Government of Rwanda, UNEP.

REMA. 2010. *Practical Tools on Soil and Water Conservation Measures.Tool and Guideline 5.* Kigali: Rwanda Environment Management Authority, Republic of Rwanda.

REMA;MINIRENA. 2009. *Rwanda's Fourth National Report to the Convention on Biological Diversity.*Kigali: Republic of Rwanda.

Reynolds, J. 2001. *New initiatives on land degradation*. LUCC Newsletter, Vol No. 7.Scoones, I. (1998). *Sustainable Rural Livelihoods: A framework for analysis. IDS, Working Paper 72, IDS, Brighton, UK, June 1998.* Institute for Development Studies (IDS).

Senait, R. 2005. *Determinants of choice of land management practices: A case of Ankober District.* . Ethiopia.

Sentis, I. P.2010. *College on Soil Physics: Soil Physical Properties and Processes under Climate Change.Hydrological Approach to Soil and Water Conservation. In I. Pla, Hydrological approach to soil and water conservation. In: "Man and Soil at the* (pp. I: 65-87). Geoforma Ed. Logroño (Spain): Departament de Medi Ambient i CiènciesdelSòlUniversitat de Lleida, Spain.

Holden, S. 1998. *Resource degradation and adoption of land conservation* *technologies in the Ethiopian Highlands: A case study in AnditTid, North Shewa.* Journal of Agricultural Economics, 241-256.

Shisanya, C. A., and J.A.Obando.2012..*Analysis of Factors Influencing Adoption of Soil and Water Conservation Technologies in Ngaciuma Sub-Catchment, Kenya. African* Journal of Basic & Applied Sciences, 4 (5): 172-185, 2012.

Singh, R.,R. Kuma and T.Woodhead.2002. *Smallholder Farmers. Smallholder Farmers in India: Food Security and Agricultural Policy. RAP publication: 2002/03.* Bangkok, Thailand: FAO Regional Office for Asia and the Pacific.

Stocking, M. 1985.*Soil conservation policy in colonial Africa.*Agricultural History, vol. 59, pp 148–161.

Swift, J. 1996. *Desertification: Narratives, winners and losers. In M. L. In, The Lie of the Land: Challenging Received Wisdom on the African Environment* (pp. 73¬90). Oxford: James Currey.

TERRAFRICA .2011. *Sustainable land Management in Practice. Guidelines and Best Practices for Sub-Saharan Africa.FieldApplication.*Rome, Italy: WOCAT and FAO.

Tewodros Melesse. 2010.*Determinants of Coffee Husk Manure Adoption: A Case Study from Southern Ethiopia.* Journal of Agricultural Economics.Volume 65, No 1. January - March.

Toborn, J. 2011. *Adoption of agricultural innovations, converging narratives, and the role of Swedish agricultural research for development?*2011-01-28. Discussion Paper.

Turner, B., G.Hyden and R.Kates, R. 1993.*Population Growth and Agricultural Change in Africa, Gainsville.* Florida: University Press of Florida.

UNCCD. 1994. *United Nations Convention to Combat Desertification in those countries experiencing serious Drought and/or desertification, particularly in Africa.* Retrieved December 18, 2014, from http://www.unccd.int/convention/text/pdf/conv-eng.pdf.

Varallyay, G. Y. 1990. *Influence of climatic change on soil moisture regime, texture, structure, and erosion. In H. W.* al, *Soil on a Warmer Earth.Elsevie*(pp. 39-49). Amsterdam. The Netherlands.

Wagayehu Bayene. 2003. *Economics of Soil and Water Conservation. Theory and Empirical Application to Subsistence Farming in the Eastern Ethiopian Highlands.PhD. Dissertation.*Uppsala, Sweden: Swedish University of Agricultural Sciences.

Willoughby, R.and L. Forsythe. 2011.*Farming for Impact –A Case Study of Smallholder Agriculture in Rwanda.*Concern Worldwide and Natural Resources Institute, University of Greenwich.

WOCAT. 2007. *Where the Land is Greener. Case studies and analysis of soil and water conservation technologies.*

WOCAT.2010. *Sustainable Land Management.*Retrieved November 27, 2014,

Yishak, G. 2005. *Determinants of Adoption of Improved Maize Technology in Damot Gale Woreda, Wolaita,Ethiopia. MSc Thesis. AlemayaUniversity.*Alemaya, Ethiopia: Alemaya University.

Yohannes Getachaw. 1999. *The use, maintenance and development of soil and water conservation measures by small-scale farming households in different agro-climatic zones of Northern Showa and Southern Wello, Ethiopia. PhD Thesis.*Bern, Switzerland

APPENDICES

APPENDIX I: HOUSEHOLD QUESTIONNAIRE

HAWASSA UNIVERSITY, WONDO GENET COLLAGE OF FORESTRY AND NATURAL RESOURCES, WONDO GENET, ETHIOPA

THE EFFECTIVENESS OF SOIL AND WATER CONSERVATION AS CLIMATE SMART AGRICULTURAL PRACTICE AND ITS CONTRIBUTION TO SMALL HOLDER FARMERS LIVELIHOODS IN BAMBASI DISTRICT OF BENISHANGUL GUMUZ REGION, ETHIOPIA

My name is ASHAFI MOHAMMED, a post-graduate student at **Hawassa University, Wondo Genet Collage of Forestry and Natural Resources**. I am conducting a research to assess the effectiveness of soil and water conservation activities and its contribution to livelihoods of smallholders in Bambasi District of BenishangulGumuz Region, Ethiopia. To meet the objectives of the study several techniques are being used including conducting discussion with smallholders. Please assist by contributing your valuable idea in completing this questionnaire. The information obtained will be used sorely for the purposes of this study and will be confidential. Thank you very much.

HOUSEHOLD QUESTIONNAIRE

NAME OF WOREDA: DATE:

NAME OF KEBELE:

NAME OF HOUSEHOLD HEAD:

SECTION A: DEMOGRAPHICS

1. Gender of respondents

1. Male ☐ Female ☐

2. Marital Status of respondent

☐ Single ☐ Married ☐ Widowed ☐ Divorced

3. Occupation of respondents

(i)……………………………………………….
(ii)……………………………………………….
(iii)………………………………………………
(iv)………………………………………………
(v)……………………………………………….
(vi)………………………………………………

4. i. Ages of respondents

☐10-20 ☐-30 31☐0 41-5☐ 51-60 ☐ 60 and ab☐

ii. Family size: ………………………………..

5. Level of Education

☐ No education ☐Read and Write ☐mary level (1-8) Hig☐chool (9-12)

☐College/University

SECTION B: LAND USE SYSTEM

7. Farm characteristics

7.1. Where is your farm located?

Up☐d Marsh☐d

Others specify……………………………………………………………………………………

7.2. If it is in marshland, did you consolidate your farm?

☐Yes ☐

8. (a) Which type of land use system do you use?

……
……
……
………………………………………………

(b) What is the size of your farm?

B☐w 0.3ha 0.3.-0.8☐ 0.9-1.4ha ☐ 1.5-2ha ☐ove 2ha ☐

(c) (i) What type of crop do you plant?

………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………

(ii) What kind of animal do you raise?

………………………………………………………………………………………………………
………………………………………………………………………………………………………
……………………………………………………………………………………………………...

9. Do you have any problem of land/ soil degradation?

☐Yes ☐o

If yes, what type of land degradation?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………………………

10.What are causes of land degradation on your farm?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

SECTION C: SOIL AND WATER CONSERVATION PRACTICES AND TECHNOLOGIES USED

11. What do you do to minimize of land /soil degradation?
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

12. Do you know about SWC Technologies?
☐Yes ☐o

13. Do you use any SWC technologies? If yes, what ones?
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

14. At which extent those SWC technologies are being used?
☐Below 25% ☐-50% 50☐5% 75 – 1☐%

15. What are the factors influenced you to use SWC technologies?
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

16. For how long have you been using these technologies?
…………………………………………………………………………………………
…………………………………………………………………………………………

17. How did you know about these SWC technologies?
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

18. Why did you choose to use SWC technologies?
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

19. Have women participated in SWC Technologies?
☐Yes ☐o

20. What are the benefits you get by using the SWC technologies?
……………………………………………………………………………………………
……………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………………………………..

21. What are the advantages and disadvantages of SWC Technologies? What problems do you face in using SWC technologies?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

22. What are the effects on your livelihood?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

23. What are the effects of SWC technologies on the natural environment?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

24. What help do you receive from Government and NGOs?

(i) Government

……

……

……

……………………………………………………

(ii) NGOs

……

……

……….

25. What more help would you like to receive as far as SWC technologies is concerned?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………....

APPENDIX II: INTERVIEW GUIDE

HAWASSA UNIVERSITY, WONDO GENET COLLAGE OF FORESTRY AND NATURAL RESOURCES, WONDO GENET, ETHIOPA

THE EFFECTIVENESS OF SOIL AND WATER CONSERVATION AS CLIMATE SMART AGRICULTURAL PRACTICE AND ITS CONTRIBUTION TO SMALL HOLDER FARMERS LIVELIHOODS IN BAMBASI DISTRICT OF BENISHANGUL GUMUZ REGION, ETHIOPIA

My name is ASHAFI MOHAMMED, a post-graduate student at **Hawassa University, Wondo Genet Collage of Forestry and Natural Resources**. I am conducting a research to assess the effectiveness of soil and water conservation activities and its contribution to livelihoods of smallholders in Bambasi District of BenishangulGumuz Region, Ethiopia. To meet the objectives of the study several techniques are being used including conducting discussion with smallholders. Please assist by contributing your valuable idea in completing this questionnaire. The information obtained will be used sorely for the purposes of this study and will be confidential. Thank you very much.

INTERVIEW GUIDE

NAME OF WOREDA: DATE:

NAME OF KEBELE:

NAME OF RESPONDENT:
DEPARTMENT/SECTION:
1.Are there any SWC technologies in this area?
☐Yes ☐
If Yes, which ones?
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………..
2. What are factors contributing to the adoption of SWC technologies?
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………..
3. What are the most SWC technologies used in the study area and what are the criteria used to choose such SWC technologies?
………………………………………………………………………………………………
………………………………………………………………………………………………

…………………………………………………………………………………………
…………………………………………………………………………………………
At what extent they are used?
Below 25% ☐ 25 – 50% ☐ 50 – 75% ☐ 75 – 100% ☐
4. How have these SWC technologies impacted farmers" livelihood?
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
5.How have SWC technologies impacted women farmers?
…………………………………………………………………………………………
………………………………………………………………………………………………
…………………………………………………………………………………………
6. How do you support farmers whose farms are eroded or degraded and which kinds of support doyou provide them?
…………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………
7. What do you plan for the farmers whose farms have not any SWC technologies and are susceptible to land/ soil degradation?
…………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
8. What are the effects of SWC technologies on natural environment?
…………………………………………………………………………………………
……………………………………………………………………………
……………………………………………………………………………………….....
9. What would you like to do for supporting farmers to invest in SWC technologies in order to maximize the SWC technologies benefits?
……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………………………

APPENDIX III: OBSERVATION SCHEDULE

The observation helped the researcher to observe the characteristics of the study area along with the most SWC practices and technologies adopted in the study area. Additionally, types of crops and livestockwere also observed.

The following are the important things that were observed:

1. The most SWC technologies used in the study area
………
………
……………………………………………………
2. Types of crops
………………………………………………………………………………………………
………………………………………………………………………………………………
3.Types of livestock
………………………………………………………………………………………………
………………………………………………………………………………………………
4.The size of farm
………………………………………………………………………………………………
………………………………………………………………………………………………
5.The location of farm
………………………………………………………………………………………………
………………………………………………………………………………………………

APPENDIX IV: CHI-SQUARE RESULTS

Appendix 4.1. Age and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Age * Number of SWC adopted Cross tabulation

		Number of SWC adopted				Total
		1	2	3	4	
≤20	Count	**0**	**2**	**1**	**1**	**4**
	Expected Count	.4	1.3	.8	1.5	4.0
	% within Age	0.0%	50.0%	25.0%	25.0%	100.0%
	% within Number of SWC adopted	0.0%	2.3%	1.8%	1.0%	1.5%
	% of Total	0.0%	0.7%	0.4%	0.4%	1.5%
21-40	Count	15	36	31	43	125
	Expected Count	11.6	40.7	25.5	47.2	125.0
	% within Age	12.0%	28.8%	24.8%	34.4%	100.0%
	% within Number of SWC adopted	60.0%	40.9%	56.4%	42.2%	46.3%
	Count	15	36	31	43	125
41-60	Count	10	32	19	40	101
	Expected Count	9.4	32.9	20.6	38.2	101.0
	% within Age	9.9%	31.7%	18.8%	39.6%	100.0%
	% within Number of SWC adopted	40.0%	36.4%	34.5%	39.2%	37.4%
	% of Total	3.7%	11.9%	7.0%	14.8%	37.4%
≥61	Count	0	18	4	18	40
	Expected Count	3.7	13.0	8.1	15.1	40.0
	% within Age	0.0%	45.0%	10.0%	45.0%	100.0%
	% within Number of SWC adopted	0.0%	20.5%	7.3%	17.6%	14.8%
	% of Total	0.0%	6.7%	1.5%	6.7%	14.8%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Age	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.642	9	.179

Appendix 4.2. Chi Square tests HH size and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
HH size * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

HH size * Number of SWC adopted Cross tabulation

		Number of SWC adopted	Total			Total
		1	2	3	4	
1to 3 persons	Count	8	21	14	13	56
	Expected Count	5.2	18.3	11.4	21.2	56.0
	% within HH size	14.3%	37.5%	25.0%	23.2%	100.0%
	% within Number of SWC adopted	32.0%	23.9%	25.5%	12.7%	20.7%
	% of Total	3.0%	7.8%	5.2%	4.8%	20.7%
4 to 6 persons	Count	17	62	38	86	203
	Expected Count	18.8	66.2	41.4	76.7	203.0
	% within HH size	8.4%	30.5%	18.7%	42.4%	100.0%
	% within Number of SWC adopted	68.0%	70.5%	69.1%	84.3%	75.2%
	% of Total	6.3%	23.0%	14.1%	31.9%	75.2%
7 to 9 persons	Count	0	5	3	3	11
	Expected Count	1.0	3.6	2.2	4.2	11.0
	% within HH size	0.0%	45.5%	27.3%	27.3%	100.0%
	% within Number of SWC adopted	0.0%	5.7%	5.5%	2.9%	4.1%
	% of Total	0.0%	1.9%	1.1%	1.1%	4.1%
≥10 persons	Count	17	62	38	86	203
	Expected Count	18.8	66.2	41.4	76.7	203.0
	% within HH size	8.4%	30.5%	18.7%	42.4%	100.0%
	% within Number of SWC adopted	68.0%	70.5%	69.1%	84.3%	75.2%

	Count	17	62	38	86	203
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within HH size	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.666	6	.139

Appendix 4.3. Chi Square tests Education level and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Education * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Education * Number of SWC adopted Cross tabulation

		Number of SWC adopted	Total			Total
		1	2	3	4	
No education	Count	24	86	55	102	267
	Expected Count	24.7	87.0	54.4	100.9	267.0
	% within have Extension service	9.0%	32.2%	20.6%	38.2%	100.0%
	% within Number of SWC adopted	96.0%	97.7%	100.0%	100.0%	98.9%
	% of Total	8.9%	31.9%	20.4%	37.8%	98.9%
Read & write	Count	1	2	0	0	3
	Expected Count	.3	1.0	.6	1.1	3.0
	% within extension service	33.3%	66.7%	0.0%	0.0%	100.0%
	% within Number of SWC adopted	4.0%	2.3%	0.0%	0.0%	1.1%
	% of Total	0.4%	0.7%	0.0%	0.0%	1.1%
Primary	Count	1	5	2	1	9
	Expected Count	.8	2.9	1.8	3.4	9.0
	% within	11.1%	55.6%	22.2%	11.1%	100.0%

	Education					
	% within Number of SWC adopted	4.0%	5.7%	3.6%	1.0%	3.3%
	% of Total	0.4%	1.9%	0.7%	0.4%	3.3%
Secondary/high school	Count	0	0	3	3	6
	Expected Count	.6	2.0	1.2	2.3	6.0
	% within Education	0.0%	0.0%	50.0%	50.0%	100.0%
	% within Number of SWC adopted	0.0%	0.0%	5.5%	2.9%	2.2%
	% of Total	0.0%	0.0%	1.1%	1.1%	2.2%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Extension service	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.024	9	.090

Appendix 4.4. Knowledge from Extension services and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Extension service * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Extension service * Number of SWC adopted Crosstabulation

		Number of SWC adopted	Total			Total
		1	2	3	4	
Have knowldge	Count	24	86	55	102	267
	Expected Count	24.7	87.0	54.4	100.9	267.0
	% within have Extension service	9.0%	32.2%	20.6%	38.2%	100.0%
	% within Number of SWC adopted	96.0%	97.7%	100.0%	100.0%	98.9%
	% of Total	8.9%	31.9%	20.4%	37.8%	98.9%

Don't have	Count	1	2	0	0	3
	Expected Count	.3	1.0	.6	1.1	3.0
	% within extension service	33.3%	66.7%	0.0%	0.0%	100.0%
	% within Number of SWC adopted	4.0%	2.3%	0.0%	0.0%	1.1%
	% of Total	0.4%	0.7%	0.0%	0.0%	1.1%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Extension service	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.744	3	.192

Appendix 4.5. Trainings and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Trainings * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Trainings * Number of SWC adopted Crosstabulation

Knowledge from others

		Number of SWC adopted				Total
		1	2	3	4	
Adopt due to trainings	Count	22	78	21	37	158
	Expected Count	14.6	51.5	32.2	59.7	158.0
	% within Trainings	13.9%	49.4%	13.3%	23.4%	100.0%
	% within Number of SWC adopted	88.0%	88.6%	38.2%	36.3%	58.5%
	% of Total	8.1%	28.9%	7.8%	13.7%	58.5%
Don't adopt due to trainings	Count	3	10	34	65	112
	Expected Count	10.4	36.5	22.8	42.3	112.0
	% within Trainings	2.7%	8.9%	30.4%	58.0%	100.0%
	% within Number of SWC adopted	12.0%	11.4%	61.8%	63.7%	41.5%
	% of Total	1.1%	3.7%	12.6%	24.1%	41.5%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Trainings	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	71.997	3	.000

Appendix 4.6. Knowledge form others and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Knowledge from others * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Knowledge from others * Number of SWC adopted Crosstabulation

	Expected Count	.6	2.0	1.2	2.3	6.0
	% within Knowledge from others	0.0%	66.7%	16.7%	16.7%	100.0%
	% within Number of SWC adopted	0.0%	4.5%	1.8%	1.0%	2.2%
	% of Total	0.0%	1.5%	0.4%	0.4%	2.2%
Don’t have	Count	25	84	54	101	264
	Expected Count	24.4	86.0	53.8	99.7	264.0
	% within Knowledge from others	9.5%	31.8%	20.5%	38.3%	100.0%
	% within Number of SWC adopted	100.0%	95.5%	98.2%	99.0%	97.8%
	% of Total	9.3%	31.1%	20.0%	37.4%	97.8%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Knowledge from others	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of	100.0%	100.0%	100.0%	100.0%	100.0%

	SWC adopted					
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.519	3	.318

Appendix 4.7.Farm size and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Farm Size * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Farm Size * Number of SWC adopted Crosstabulation

		Number of SWC adopted		Total		Total
		1	2	3	4	
Farm Size <2ha	Count	25	76	53	80	234
	Expected Count	21.7	76.3	47.7	88.4	234.0
	% within Farm Size	10.7%	32.5%	22.6%	34.2%	100.0%
	% within Number of SWC adopted	100.0%	86.4%	96.4%	78.4%	86.7%
	% of Total	9.3%	28.1%	19.6%	29.6%	86.7%
Farm size ≥2ha	Count	0	12	2	22	36
	Expected Count	3.3	11.7	7.3	13.6	36.0
	% within Farm Size	0.0%	33.3%	5.6%	61.1%	100.0%
	% within Number of SWC adopted	0.0%	13.6%	3.6%	21.6%	13.3%
	% of Total	0.0%	4.4%	0.7%	8.1%	13.3%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Farm Size	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistics	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.315	3	.003

Appendix 4.8. Livestock rearing and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Livestock rearing * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Livestock rearing * Number of SWC adopted Crosstabulation

		Number of SWC adopted				Total
		1	2	3	4	
Have Livestock rearing	Count	23	82	54	99	258
	Expected Count	23.9	84.1	52.6	97.5	258.0
	% within Livestock rearing	8.9%	31.8%	20.9%	38.4%	100.0%
	% within Number of SWC adopted	92.0%	93.2%	98.2%	97.1%	95.6%
	% of Total	8.5%	30.4%	20.0%	36.7%	95.6%
Don’t have	Count	2	6	1	3	12
	Expected Count	1.1	3.9	2.4	4.5	12.0
	% within Livestock rearing	16.7%	50.0%	8.3%	25.0%	100.0%
	% within Number of SWC adopted	8.0%	6.8%	1.8%	2.9%	4.4%
	% of Total	0.7%	2.2%	0.4%	1.1%	4.4%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Livestock rearing	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.348	3	.341

Appendix 4.9. Member of Cooperative and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
cooperatives * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Cooperatives * Number of SWC adopted Crosstabulation

		Number of SWC adopted	Total			Total
		1	2	3	4	
Member of Cooperative	Count	0	59	1	0	60
	Expected Count	5.6	19.6	12.2	22.7	60.0
	% within cooperatives	0.0%	98.3%	1.7%	0.0%	100.0%
	% within Number of SWC adopted	0.0%	67.0%	1.8%	0.0%	22.2%
	% of Total	0.0%	21.9%	0.4%	0.0%	22.2%
	Count	25	29	43	83	180
	Expected Count	16.7	58.7	36.7	68.0	180.0
	% within cooperatives	13.9%	16.1%	23.9%	46.1%	100.0%
	% within Number of SWC adopted	100.0%	33.0%	78.2%	81.4%	66.7%
	% of Total	9.3%	10.7%	15.9%	30.7%	66.7%
Cooperative	Count	0	0	11	19	30
	Expected Count	2.8	9.8	6.1	11.3	30.0
	% within cooperatives	0.0%	0.0%	36.7%	63.3%	100.0%
	% within Number of SWC adopted	0.0%	0.0%	20.0%	18.6%	11.1%
	% of Total	0.0%	0.0%	4.1%	7.0%	11.1%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within cooperatives	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)

Pearson Chi-Square	163.312	6	.000

Appendix 4.10: Crop yield and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Crop yield * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Crop yield * Number of SWC adopted Crosstabulation

		Number of SWC adopted		Total		Total
		1	2	3	4	
Due to crop yield	Count	22	74	45	98	239
	Expected Count	22.1	77.9	48.7	90.3	239.0
	% within Crop yield	9.2%	31.0%	18.8%	41.0%	100.0%
	% within Number of SWC adopted	88.0%	84.1%	81.8%	96.1%	88.5%
	% of Total	8.1%	27.4%	16.7%	36.3%	88.5%
Don't reported	Count	3	14	10	4	31
	Expected Count	2.9	10.1	6.3	11.7	31.0
	% within Crop yield	9.7%	45.2%	32.3%	12.9%	100.0%
	% within Number of SWC adopted	12.0%	15.9%	18.2%	3.9%	11.5%
	% of Total	1.1%	5.2%	3.7%	1.5%	11.5%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Crop yield	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.869	3	.020

Appendix 4.11: Soil erosion and Number of SWC Technologies adopted

Case Processing Summary

	Cases

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Soil erosion * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Soil erosion * Number of SWC adopted Crosstabulation

		Number of SWC adopted	Total			Total
		1	2	3	4	
Experience of soil erosion	Count	14	61	41	84	200
	Expected Count	18.5	65.2	40.7	75.6	200.0
	% within Soil erosion	7.0%	30.5%	20.5%	42.0%	100.0%
	% within Number of SWC adopted	56.0%	69.3%	74.5%	82.4%	74.1%
	% of Total	5.2%	22.6%	15.2%	31.1%	74.1%
Don't experience soil erosion	Count	11	27	14	18	70
	Expected Count	6.5	22.8	14.3	26.4	70.0
	% within Soil erosion	15.7%	38.6%	20.0%	25.7%	100.0%
	% within Number of SWC adopted	44.0%	30.7%	25.5%	17.6%	25.9%
	% of Total	4.1%	10.0%	5.2%	6.7%	25.9%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Soil erosion	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.936	3	.030

Appendix 4.12: High slope and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Soil erosion * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

High slope * Number of SWC adopted Crosstabulation

Due to high		Number of SWC adopted	Total			Total

slope						
		1	2	3	4	
	Count	3	37	4	6	50
	Expected Count	4.6	16.3	10.2	18.9	50.0
	% within High slope	6.0%	74.0%	8.0%	12.0%	100.0%
	% within Number of SWC adopted	12.0%	42.0%	7.3%	5.9%	18.5%
	% of Total	1.1%	13.7%	1.5%	2.2%	18.5%
Don't adopt due to high slope	Count	22	51	51	96	220
	Expected Count	20.4	71.7	44.8	83.1	220.0
	% within _High slope	10.0%	23.2%	23.2%	43.6%	100.0%
	% within Number of SWC adopted	88.0%	58.0%	92.7%	94.1%	81.5%
	% of Total	8.1%	18.9%	18.9%	35.6%	81.5%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within High slope	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	48.388	3	.000

Appendix 4.13. Availability of inputs and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Inputs (Support) * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Inputs (Support) * Number of SWC adopted Crosstabulation

		Number of SWC adopted		Total		Total
Reported due to availability of inputs		1	2	3	4	
	Count	14	83	36	55	188
	Expected Count	17.4	61.3	38.3	71.0	188.0

	% within Inputs (Support)	7.4%	44.1%	19.1%	29.3%	100.0%
	% within Number of SWC adopted	56.0%	94.3%	65.5%	53.9%	69.6%
	% of Total	5.2%	30.7%	13.3%	20.4%	69.6%
Don’t report	Count	11	5	19	47	82
	Expected Count	7.6	26.7	16.7	31.0	82.0
	% within Inputs (Support)	13.4%	6.1%	23.2%	57.3%	100.0%
	% within Number of SWC adopted	44.0%	5.7%	34.5%	46.1%	30.4%
	% of Total	4.1%	1.9%	7.0%	17.4%	30.4%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Inputs (Support)	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	39.916	3	.000

Appendix 4.14: Farmers‟ experience and Number of SWC Technologies adopted

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Experience * Number of SWC adopted	270	100.0%	0	0.0%	270	100.0%

Experience * Number of SWC adopted Crosstabulation

		umber of SWC adopted		Total		Total
		1	2	3	4	
Below 4 years	Count	0	1	51	102	154
	Expected Count	14.3	50.2	31.4	58.2	154.0
	% within Experience	0.0%	0.6%	33.1%	66.2%	100.0%
	% within Number of SWC adopted	0.0%	1.1%	92.7%	100.0%	57.0%
	% of Total	0.0%	0.4%	18.9%	37.8%	57.0%

Above 4 years	Count	25	87	4	0	116
	Expected Count	10.7	37.8	23.6	43.8	116.0
	% within Experience	21.6%	75.0%	3.4%	0.0%	100.0%
	% within Number of SWC adopted	100.0%	98.9%	7.3%	0.0%	43.0%
	% of Total	9.3%	32.2%	1.5%	0.0%	43.0%
Total	Count	25	88	55	102	270
	Expected Count	25.0	88.0	55.0	102.0	270.0
	% within Experience	9.3%	32.6%	20.4%	37.8%	100.0%
	% within Number of SWC adopted	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	9.3%	32.6%	20.4%	37.8%	100.0%

Chi-Square Tests

Statistic	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	250.829	3	.000