



SEEK WISDOM, ELEVATE YOUR INTELLECT AND SERVE HUMANITY!



**SOIL CONSERVATION PRACTICES AND ITS CONTRIBUTION TO
FOOD SECURITY IN CHENCHA WOREDA SNNP, ETHIOPIA**

**A THESIS SUBMITTED TO
ADDIS ABABA UNIVERSITY COLLEGE OF DEVELOPMENT STUDIES
CENTER FOR FOOD SECURITY**

**BY
ABDI HASSEN ESSA**

ADDIS ABABA UNIVERSITY

**Addis Ababa
October, 2019**

ADDIS ABABA UNIVERSITY
COLLEGE OF DEVELOPMENT STUDIES
CENTER FOR FOOD SECURITY STUDIES

**SOIL CONSERVATION PRACTICES AND ITS CONTRIBUTION TO FOOD
SECURITY IN CHENCHA WOREDA, SOUTHERN ETHIOPIA**

BY
ABDI HASSEN

THESIS ADVISOR
AMARE BANTIDER (PHD)

**A THESIS SUBMITTED TO CENTER FOR FOOD SECURITY STUDIES IN PARTIAL
FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF
SCIENCE (MSC) IN FOOD SECURITY AND DEVELOPMENT STUDIES**

Addis Ababa, Ethiopia

October, 2019

Declaration

I Abdi Hassen Essa, hereby declare that the thesis entitled: “*Soil Conservation Practice and its Implication to Food Security in Chenchu Woreda, Ethiopia*”, A Thesis submitted to the award of the Degree of Master of Science (Msc) in Food Security and Development Studies at Addis Ababa University, is a product of my original work and it hasn't been presented for the award of any other Degree, Diploma, Fellowship of any other university or institution. This work has also accredited the views of the research participants. To the best of my knowledge, I have fully acknowledged the materials and pieces of information used in the study.

Name: Abdi Hassen Essa

Signature _____

Addis Ababa University

College of Development Studies

Center for Food Security Studies

This is to certify that this thesis entitled: “*Soil Conservation Practice and its Implication to Food Security in Chenchu Woreda, Ethiopia*”, prepared by Abdi Hassen and submitted in partial fulfillment of the requirements for the award of degree of **Master of Science (Msc) in Food Security and Development Studies** complies with the regulation of the University and meets the accepted standards with respect to originality and quality.

Approved By Boards of Advisor and Examiners

Advisor

Signature

Date

Internal Examiner

Signature

Date

External Examiner

Signature

Dat

ACKNOWLEDGEMENT

Above all I thank the LORD ALAH for giving me the strength to start and go through with my studies. I would particularly like to extend my heartfelt thanks and appreciation to my adviser Dr. Amare Bantider for his follow up, devotion of his precious time, valuable suggestions, and constructive comments and systematic guidance to improve the content of this paper. He also deserves my utmost gratitude for his encouragement, and on time responses. My sincere thanks go to Chenchaworeda Agriculture staff and Ministry of Agriculture for their giving relevant data. Enumerators Chisha, Adimasu and werkaferaw are also acknowledged for their efforts to get reliable information in time of interviewing farmers. I would like to extend my appreciation for all interviewed farmers for their giving me time and permission to observe their plots. I am most deeply grateful to my friend, Melisew Assefa and Musbah Kedir for helping me strive towards the realization of my potentials, initiation, encouragement and moral support. Finally, I would like to express my gratitude to friends who were directly or indirectly involved to add their efforts, encouragement and moral support for the accomplishment of this study.

Table of Contents

<i>Contents</i>	<i>page</i>
ACKNOWLEDGEMENT -----	<i>i</i>
Acronyms and Abbreviations -----	<i>vi</i>
Abstract -----	<i>vii</i>
1. INTRODUCTION -----	1
1.1. Background -----	1
1.2. Statement of the Problem -----	3
1.3. Objectives of the Study -----	5
1.3.1. Main objective-----	5
1.3.2. Specific objectives-----	5
1.4. Research Question -----	5
1.5. Significance of the Study -----	5
1.6. Scope of the Study -----	6
1.7. Limitation of the Study -----	7
1.8. Organization of the Study -----	7
2. REVIEW OF LITERATURE -----	8
2.1. Overview of soil erosion -----	8
2.2. Causes of Soil Erosion -----	9
2.3. Types of Soil Conservation Practices -----	10
2.3.1. Physical soil conservation measures-----	11
2.3.2. Biological soil conservation measures-----	12
2.4. Factor Affecting Adoption of Soil Conservation Methods -----	13
2.5. Soil Conservation Efforts in Ethiopia -----	16
2.6. Household Food Security -----	18
2.6.1. Food Security Concept-----	18
2.6.2. Food Insecurity-----	20
2.6.3. Global Food Security Situation-----	20
2.7. Food Security and Soil Conservation Management -----	21
2.8. Conceptual Framework -----	22
3. MATERIAL AND METHODS -----	28
3.1. Description of the Study Area -----	28

3.1.1.	Geographical Location -----	28
3.1.2.	Population of the Study Area-----	28
3.1.3.	Topography and climate of the Study Area-----	29
3.1.4.	Land Use Systems and Coverage of the Study Area -----	29
3.1.5.	Livelihood Zone-----	29
3.2.	Research Method -----	31
3.2.1.	Research Design -----	31
3.2.2.	Data sources -----	31
3.2.3.	Sampling Techniques-----	32
3.2.4.	Sampling Size Determination -----	33
3.2.5.	Methods of Data collection -----	33
3.2.6.	Method of Data Analysis -----	34
4.	RESULTS AND DISCUSSION -----	37
4.1.	Descriptive analysis -----	37
4.1.1.	Descriptive analysis of soil conservation Practices on farmland in the study area -----	37
4.1.2.	Chi-square test for soil conservation practices -----	40
4.1.3.	T - Test distribution of household heads characteristics and adoption of soil conservation practices 42	
4.1.4.	Chi-square distribution of household heads in terms of adoption status-----	44
4.1.5.	Food security status and adoption of SC technology of the households -----	47
4.1.6.	Descriptive statistics for socioeconomic variables and food security in the study -----	48
4.1.7.	Coping strategies used by farmers to overcome food shortages -----	56
4.2.	Econometric Analysis-----	57
4.2.1.	Logistic regression analysis of the food security -----	57
5.	CONCLUSION AND RECOMMENDATION -----	62
5.1.	Summary and Conclusion -----	62
5.2.	Recommendation -----	64
6.	REFERENCE-----	65
7.	APPENDIX - 1-----	70
8.	Appendix 2-----	77
9.	Appendix 3-----	77

List of Table

Table	Page
Table 1 Soil Conservation practices applied in the study area	40
Table 2 Chi square test of use of physical conservation methods	41
Table 3 Chi square test for use of biological soil conservation methods	41
Table 4 T-test distribution of variables by SC technology adoption status	44
Table 5 Chi-square distribution of variables by SC technology adoption status	47
Table 6 Chi-square test of food security status and adoption of soil conservation practices.....	48
Table 7 Descriptive statistics of continuous independent variables.....	50
Table 8 Descriptive statistics of Dummy/ discrete Independent Variables (χ^2 test).....	53
Table 9 χ^2 Test for source of land and Slope	55
Table 10 Months with series food shortage and households coping for food shortage.....	56
Table 11 Marginal effect after logistic regression of food security status.....	58

List of figures

Figure	Page
Figure 1 Conceptual Frame work	27
Figure 2 Map of Study area	30

List of Figures in the Appendix

Figure 3 Normality Test for square root of total income	79
Figure 4 Normality test for ln of family size	79
Figure 5 Box plot check for out layers variable total income	79
Figure 6 Box plot check for out layers (Family size)	79
Figure 7 Check for out layers for distance to nearest market	80
Figure 8 Normality check for distance to the market.....	80

Acronyms and Abbreviations

CSA	Central statistical Agency
DALDO	District Agricultural and Livestock Development Office
FAO	Food and Agricultural organization
FGD	Focus Group Discussion
HFIAS	Households Food insecurity access scale
NGOs	Non-Government Organizations
MCA	Multi- Criteria Analysis
MERET	Managing Environment to Enable Transition
MoFED	Ministry of finance and economy development
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
PRA	Participatory Rapid Appraisal
PSNP	productive safety net program
SC	Soil Conservation
SNNPR	South Nation Nationality peoples Region
SWC	Soil and water Conservation
WFP	World Food Program

Abstract

This study was aimed to analyze the role of soil conservation practices to household food security in Chencha highlands, Ethiopia. Random sampling procedures were used to obtain three representative kebeles. From three kebeles of chencha woreda a total of 276 respondents were selected by random sampling method based on the proportion of population size. The method of data collection was both primary and secondary data sources. Data analysis was undertaken by using Descriptive and Inferential Statistics like t-test, chi-square test, frequency and percentage. Logistic regression model was employed to analyzed factors affecting food security status of households. Analysis was done using STATA version 22 software. The result indicated that there was a significant difference between adopters and non-adopters in terms of household age, farm size, family size, off-farm income, Calorie per adult equivalent per day. The result also revealed a significant difference between adopters and non-adopters in terms of sex, education, farm slope, extension service, marital status. There was statistically significant difference between secured and insecure in terms socio-economic characteristics such as age, farm size in hectare, farm income, sex education farm slope, access to extension service. Therefore, this study recommends that soil conservation is multidimensional impact worthy of consideration to be incorporated in policy intervention by NGOs or government designed projects Development agents of the woreda or other project officers should give maximum attention to dissemination of information about soil conservation technology at door. Even more, an opportunity of employment has to be created by the regional government as it helps in the battle with food insecurity.

Key words: Adoption, Soil Conservation, Food security, logistic model, significant level

CHAPTER ONE

1. INTRODUCTION

1.1. Background

The majority of the population of Ethiopia consists of farmers and their families reside in rural areas and whose life is almost entirely dependent on agriculture. Agriculture is the main stay of the large proportion of human population of the country, even though it is threatened by human induced land degradation and climatic factors. Traditional mixed crop livestock production system under developed and dominated by subsistence farmers, focusing on household food security (Tolera et al, 2011).

Land degradation has affected a large number of people over a significant portion of the earth's surface which has led to extreme poverty and hunger. Around the world, land degradation can be viewed as any change or disturbance to land perceived to be undesirable that affect human activities like agriculture and settlements (Eswaran et al., 2001).

Soil erosion is the main form of land degradation, caused by the interacting effects of factors, such as biophysical characteristics and socio-economic aspects. Degradation resulting from soil erosion and nutrient depletion is one of the most challenging environmental problems in Ethiopia. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile land (Amsalu and de Graaff, 2006).

The most important reason for limited use of SC technologies is farmers' low adoption behavior. Kessler, (2006) considers SWC measures fully adopted only when their execution is sustained and fully integrated in the household's farming system. Adoption of SC measures does not automatically guarantee long-term use. For example, when SC measures have been established

with considerable project assistance, not all farmers may continue using the measures. Therefore, introduction of SC technologies may not lead to sustained land rehabilitation unless the farmers proceed to final adoption.

Recognizing land degradation as a major environmental and socio-economic problem, the government of Ethiopia has made several interventions. As a result, large areas have been converted to terraces, covered by soil bunds, closed by area closures and planted with millions of tree seedlings. Nevertheless, the achievements have fallen far below expectations. The country still loses a tremendous amount of fertile topsoil, and the threat of land degradation is broadening alarmingly (Teklu and Gezahegn, 2003).

Food security has been a problem for people in the world. In particular developing countries, such as Ethiopia, have been facing severe version of this problem over a longer period of time. The complex interaction in the process of decision making in the context of adverse environmental conditions has made it difficult to tackle the problem in the short run (Tesfahun et al., 2003).

The majority of the population of Ethiopia consists of farmers and their families reside in rural areas and whose life is almost entirely dependent on agriculture. Agriculture is the main stay of the large proportion of human population of the country, even though it is threatened by human induced land degradation and climatic factors. Traditional mixed crop livestock production system under developed and dominated by subsistence farmers, focusing on household food security (Tolera et al, 2011).

Soil erosion is the major problem that affects crop yields leading to low income of the small scale farmers and subsequently food insecurity. According to FAO, (2004) food security exists

when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The definition indicates direct relationship between agricultural production, food security and income. In order to address food security and income which generally depend on increased agricultural production, more efforts should be directed to the improvement of appropriate land management practices. Improved soil erosion control measures should aim at increased agricultural production hence improved household income and food security.

1.2. Statement of the Problem

In Ethiopia, food insecurity has been a serious problem for decades since the 1970s, a series of production failures have resulted in chronic food insecurity (Kaluski et al., 2001). In the last few Decades, 4.5 million people required immediate food assistance aid. As a result, Ethiopia has been the largest recipient of food aid (WFP, 2014). According to the Ethiopian Central Statistical Agency (2011), about 30 percent of Ethiopian population lives under poverty line and food security is a national concern of Ethiopian government. According to FAO (2015), about 52% of the rural population and 36% of the urban population consume under the minimum recommended daily intake of 2100 calorie per person per day. To combat such problems of the nation, prime attention has been given to the agricultural sector. This ultimately necessitates adopting technology that ameliorates agricultural productivity.

According to Tolera, (2011), land degradation has become a serious problem affecting all spheres of social, economic and political life of the population. It is one of the major challenges to agriculture development and food security of people in Ethiopia. In Ethiopia, the rate of the countries land degradation is very high. A large portion of agricultural land which is mainly

located in the highland part of the country is affected by severing to moderate land degradation (Bewket, (2007)).

The Southern Regional State is highly affected by soil erosion. Ninety percent of the population settled in the high land part that constitutes 66% of total land resource (Belete 2018). Areas that are seriously affected by erosion in Southern Regional state are found in Gamo Gofa zone. Among the Southern Regional state zones, Gamo Gofa is the one which is seriously affected by soil erosion. According to Gamo Gofa agricultural and Rural Development Department (GGARDD, 2014) annual report, average annual rate of soil loss is 45 tons/hectare/year on cultivated land and 22 tons/hectare/year on grazing land.

Chencha is part of Gamo Gofa zone that has been facing a serious challenge of soil erosion and land degradation. According to Woreda Agricultural and Rural Development Office (CWARD, 2014) 38% of the total land area is highly affected by soil erosion and more than 65% of agricultural land is prone to sheet, rill and gully erosion due to continuous cultivation for a centuries.

A number of studies have been conducted on soil and water conservation in southern Ethiopia, but most of them focused on farmers participation in soil and water conservation activities, by incorporating the socio economic aspects or benefits to the farmers (Tolera, M. (2011); Daniel, 2010; Aklilu, 2006). However, the findings in such studies did not relate the benefits of soil and water conservation practices to food security at household levels or there are little evidences on the contribution of soil and water conservation to sustainable food security. This problem initiates the undertaking of this research to further investigate and analyze the implication of the soil conservation practice on household food security s at household level.

1.3. Objectives of the Study

1.3.1. Main objective

The overall objective of this study is to analyze the role of soil conservation technologies to food security in Chencha highland, Ethiopia.

1.3.2. Specific objectives

The specific objectives were to:

- Assess the soil conservation practices in the study area.
- Analyze the determinants of the adoption of SC practices in the study area.
- Analyze the demographic and socioeconomic contribution to food security
- Analyze the food security status of Soil Conservation adopter households with non-adopters households.

1.4. Research Question

This study intended to answer the following research questions:

- What is the soil conservation practices implemented in the study area?
- Are the demographic and socioeconomic factors affecting the food security status of households?
- Is the food security status of Soil Conservation adopter's household differs with non-adopters households?

1.5. Significance of the Study

Farmers will benefit from this study in that they will be enlightened on the soil conservation practices contribution in order to attain food security. This will increase their knowledge on the soil conservation and the best farming methods to use in order to improve productivity.

The Government of Ethiopia will use the findings of the study to assess the soil conservation practices and food production and food security for small households in country.

Academicians and researchers will be able to learn more on soil conservation practices and how they impact on food security for small scale households, thus they will be able to analyze fully the benefits of soil conservation practices and how they impact on food production and food security. This study will help to identify areas for further study and contribute to knowledge about soil conservation practices and their -impact on food production and food security in Ethiopia.

Different studies were conducted on soil and water conservation practice and improvement on production and productivity but the researcher viewed that there is gap on the implication to food security which this study is believed to fill the gap on this area.

Different stakeholders (government and non- governmental organizations) involved in soil and water conservation practice are highly concerned with its implementation, challenges and effectiveness of the activities. The researchers, NGOs, Wordea Agricultural Office and Development workers need to understand about soil conservation measure to develop appropriate intervention and design effective policies and strategies.

1.6. Scope of the Study

Geographically, the study was conducted in SNNP Regional State, Gamo Gofa zone in Chencha Woreda. It was delimited to assess soil conservation practices and socioeconomic factors that determine food security. It is not easy to study the whole aspects such as forests, irrigation system and other environmental protection practices within the available budget, resource and material. Therefore, it was important to restrict the study size and scope of the problem in to a manageable way. So, the scope of the study was delimited to socio-economic, physical,

demographic, institutional factors and soil conservation practices and food security situation of the study area only.

1.7. Limitation of the Study

The problem the researcher faced during conducting this study includes shortage of time, unwillingness of the targeted wereda key informants and influential respondents to provide genuine knowledge, experience, lack of transportation to reach the selected kebele especially on Amaranbodo kebele was a big challenge to collect the data from households and focus group discussion timely. Expectation and personal information's due to political fear and shortage or lack of satisfactory perdim payments for this issue from the researcher were the limitations of this study.

1.8. Organization of the Study

This research study was organized into five chapters. Chapter one introduced and sets out the background information, statement of the problem, research objectives, research questions, significance, scope and limitation and organization of the study; chapter two talks about reviewed of related literature. Chapter three introduces the study area and research methods which discusses location, demographic and socio-economic profile of the study area; research design and approach; types and sources of data; sampling techniques and data collection tools; and techniques of data collection; Chapter four dealing with the results and discussion and Chapter five tries to discussed the conclusion and recommendations part.

CHAPTER TWO

2. REVIEW OF LITERATURE

2.1. Overview of soil erosion

Soil erosion is defined as the wearing away, detachment or physical removal and transportation of top soil from one place and its deposition to another by various agents including striking and moving water, blowing winds, strong waves, snow and the forces of gravity (Ayalneh, 2003). According to Hellin, (2006) soil degradation is any process that reduces the current and/or future productivity of soils. Erosion generally means destruction/deterioration of soil capacity to support crop growth. Soil and land degradation is a real threat to achieving sustainable agriculture.

Approximately 40% of the world's agricultural land is seriously degraded due to soil erosion and associated forms of land degradation (FAO, 2010). Globally, productivity of land has declined by 50% due to soil erosion which corresponds to an annual loss of 75 billion tons of soil (FAO, 2003). The situation is worse in developing countries where individual farm holdings are usually small. Most of the small farmers are poor and many of them are forced to farm small plots of land on steep hillsides due to increased population pressure (Lal , 2001). In Africa yield decrease due to soil erosion ranges from 2% to 40%, with a mean loss of 8% (Ayalneh, 2003). If current trends of soil degradation continue, the African continent might be able to feed just 25% of its population by the year 2025 (FAO, 2010). About more than 60% yields loss due to soil erosion was reported to occur in mountain and semi-arid areas of Ethiopia (Johansson, 2001). SNNP highland mountains are among the areas affected by soil erosion in Ethiopia, with an estimated annual soil loss of fertile top soil of about 25 tonnes per hectare and consequently reducing crop yields (Ayalneh, 2003).

2.2. Causes of Soil Erosion

Human activities or factors responsible for soil and land degradation include deforestation, cultivation on marginal lands and excessive grazing with high stocking rates (Lal, 2007). Due to population pressure, even steep slopes and marginal lands have been cultivated and fallow periods have become shorter and eventually abandoned (Amsalu, 2007). Soil degradation in steep lands is exacerbated by land and labour shortages, which in turn determine farmers' receptivity to soil conservation programmes. According Tadele et al., (2014) the major causes of soil degradation are poor land husbandry and unsustainable agricultural practices.

Land use/cover, soil type, slope, slope length, rainfall amount and intensity influence the rate of soil erosion (Amsalu, 20073). Land cover is important in terms of protecting the soil from kinetic energy of the rain drops which detach the soil particles. Land cover can be maintained either by planting cover crops or through use of crop residues as mulch (Misana et al., 2003). However, in some places crop residues are used for other purposes such as thatching materials for houses, fuel wood and fodder. Lal, (2007) reported that most farmers use crop residues as fodder instead of using it for mulching. Slowing the water movement on the slopes by regulating the vegetative cover ensures that water is available for plants for a longer time.

Soil properties such as texture and structure are important determinants of soil erosion (Amsalu, de Graaff, 2007). Sandy soils are easily detached by rain drops than clay soils. Loose soils are easily eroded than soils with stable aggregates. Steep slopes are more sensitive to rapid soil erosion through run-off water (Tadele et al., 2014). The only way to reduce soil erosion in hilly areas is to decrease the rate at which water moves down the slope.

SC practices on arable land are the pre-requisites for reducing the speed of run-off water. It is recommended to leave very steep slopes under natural vegetation. Severity of soil erosion increases as the length of the slope increase (Lal R, 2001). Slope length can be reduced by construction of soil and water conservation measures such as terraces and contour strips (Lal R, 2007). These structures reduce the speed of run-off water and increase infiltration rate.

Soil erosion involves the expenditure of energy in all phases from breaking down soil aggregates to run-off. The amount of erosion, however, depends upon a combination of erosivity, which is the power of the rain to cause erosion, and erodibility, which is the ability of the soil to resist the rain (Lal, 2007). Storm rains in the tropics are with high intensity which strikes on the soil and detaches soil particles. The amount of rainfall if exceeds the infiltration rate, then water starts to accumulate on the surface resulting to runoff.

Indicators of land degradation used to assess land degradation include soil nutrient levels, evidence of observed soil erosion features and crop performance assessment by farmers (Mulugeta and Karl, 2010). Replenishment of plant nutrients could come in the form of organic manures, inorganic fertilizers or biomass transfer through agro-forestry or short fallow or integration of these technologies. In order to increase farm incomes and ensure food security, intensification and diversification of crop enterprises is important due to small land holdings in some areas.

2.3. Types of Soil Conservation Practices

Soil conservation is defined as the specific use and protection of land, including wise choice of land use and pursuit of necessary measures of soil management and erosion control. According

to Heinrich (2001) soil conservation technologies can be grouped into two categories; mechanical/physical and biological measures

2.3.1. Physical soil conservation measures

Structures for soil conservation on crop land are permanent features formed from earth, stones or masonry that are designed to protect the soil from run-off water and erosion and to retain water where it is needed. The most common conservation structures include: cut-off drains, water ways, tie ridges, terraces, retention ditches, graded and non-graded channels/drains (Woldeamlak, 2006).

Soil conservation drains are of different types depending on the intended purpose. For example, graded channels are constructed with recommended gradient aimed at deviating excess water out of the farm with the speed which will not cause erosion. These channels are suitable in areas with high rainfall. Contour bands are another type constructed with zero gradient aimed to reduce the speed of run-off water, trap the soil particles and allow water to infiltrate in the soil (Eleni, 2008; John, 2008). Contour bands are suitable in areas with moderate rainfall. Tie ridges are constructed in such a way that the channels are tied to allow water collection and increase water infiltration in order to improve moisture content in the field. Tie ridges are practiced in arid and semi-arid areas which experienced less amount of rainfall (Woldeamlak , 2006).

Cut off drains are constructed on the upper part of the field. The cut-off drains are bigger in size compared to field drains aimed to evacuate the excess water coming from the outside of the field and safely dispose to the waterways (Eleni, 2008; John, 2008). Bench terraces are level or nearly level steps constructed on the contour and separated by embankments known as risers. They can be used on slopes of up to 55% provided that the soils are deep (Shiferaw 2005). Waterways are

natural or constructed structures used for safely disposal of run-off water collected from the fields through drains. The waterways are left with natural vegetation in order to increase roughness which reduces water velocity. Woldeamlak, (2006) emphasized that physical soil conservation measures should be properly constructed otherwise they may cause much damage than without soil conservation measures.

2.3.2. Biological soil conservation measures

Soil and water conservation measures such as live barriers, cover crops, agro-forestry, mulch and contour strips constitute biological conservation methods. Covering the soil with growing plants or plant residues has been shown to provide soil erosion protection, especially on sloping land (Glover, 2005). Slow decomposition of plant residues on the soil surface increases organic matter and total nitrogen contents in the top 5 to 15 cm soil stratum while protecting soil from erosion.

Retention of residues on the surface has been found to increase the soil nitrate (NO_3) concentration by 46%, the N uptake by 29% and the crop yields by 37% (Mandal et al., 2004). With permanent soil cover, zero tillage and a rotation of crops with green manure, crop yields in Brazil improved by a factor of 5.5 in just two years (Hellin, 2006). Farmers can improve yields by using sufficient organic mulch in the fields. This improves moisture retention capacity, suppresses weeds and decrease soil erosion.

Agro-forestry refers to land use practices where trees are integrated with crops and livestock on the same land management unit (Place et al., 2005). Trees have benefits such as timber, firewood, building materials and fruits, on top of that trees reduces soil erosion, increase organic matter and bring to the surface the plant nutrients which are found beyond crop root zone

(Woldeamlak 2006; Swallow et al., 2006). Many biological practices are aimed at maintaining and improving soil quality and productivity. Recently, more attention has been directed to the use of cover crops to protect the surface of soil from the impact of high intensity rain drops (Anderson et al., 2001).

2.4. Factor Affecting Adoption of Soil Conservation Methods

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

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

The process is set in motion by the recognition of an erosion problem. That perception is viewed as a product of the landowner's personal characteristics that might cause a more acute awareness of the seriousness of the erosion (e.g., formal education), coupled with the actual physical characteristics of the land he operates. As shown, government or academic educational programs can be used to heighten the perception of erosion problems. From an economic perspective, perception of the degree of erosion problem and its impact on short term returns and land values should be highly correlated with the farmer's willingness to pay for conservation measures.

Shiferaw and Holden (2005) noted the perception of soil erosion problems, household size, and farmer's perceptions of technology, specific attributes and land quality differentials as important in shaping conservation decision. Thus, decisions to conserve soil will be influenced by a combination of personal, economic, institutional and physical factors (John, 2008).

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

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

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

Economic Factors: Research conducted since the 1950s indicates economic constraints affect the decision to conserve soil. Economic factors may either enhance or constrain farmers'

dispositions towards erosion control. For example, high debt levels may inhibit investment in capital intensive terraces, while high net farm income will present tax advantages for the same practice. Educational programs, technical assistance, and cost sharing are institutional instruments to persuade farmers to use practices. Economic constraints such as wealth status of the farmers, off-farm income, annual income, cost of fertilizer and debt status are factors which tends to increase or reduce incentives for soil conservation (Eleni, 2008). The final step is the determination of soil conservation effort, a function of the effectiveness and extensiveness of individual practices over the farm's land.

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

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

2.5. Soil Conservation Efforts in Ethiopia

In Ethiopia the tradition of soil conservation has been common since historical times (Woldeamlak and Sterk, 2003). Yet due to inefficiency of traditional methods it was only after the famine of 1970s that many of the activities of soil conservation and resource degradation have been recognized to be a serious problem in highlands of Ethiopia. Since the early 1970s subsequently disastrous drought and famine of the time, soil conservation measures were adopted in different parts of Ethiopia. Adopted conservation methods were diversion channel, terraces, stone bund and earth dam which are mainly practiced in highlands of Ethiopia. Initially, most of the soil conservation works included construction of the stones and earth embankments, which the farmers did not appreciate (Girma, 2001).

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

The Ethiopian policy makers had largely ignored the problem of land degradation until the 1970s; apparently, the 1974 drought provided the initial motivation for the mobilization of rural labour force for conservation in the country using food for work (FFW) programmes (Gebremedhin, 2004). In addition to FFW and CFW (Cash For Work) programs, tree seedlings distribution at minimal prices for private use and free of charge for use in community lands has been another direct economic incentive used for soil conservation in the country (Gebremedhin, 2004). In fact, after nationalization much has been done to rehabilitate the eroded land.

However, the nationalization of land agrarian reform in 1974 may have contributed to deforestation of protected mountain ranges and forestlands as people no longer had an incentive to preserve them. (Girma, 2001).

During the 1980s the then Government of Ethiopia launched a massive program of soil conservation and rehabilitation. The effort, which involved heavy external support culminated in the mobilization of peasant associations with over 30 million workdays per year (Hurni, 2000). It is after this period that national efforts for soil conservation expanded rapidly. Farmers in the northern, central, and southern part of Ethiopia construct stone terraces on their sloping lands to protect them from erosion and land sliding. In most cases, the terraces are not protected with vegetative cover.

Compensation for labor, especially in the form of food- for- work (FFW), and in some cases cash- for- work (CFW), has been the main direct economic incentives used for soil conservation in Ethiopia (Gebremedhin, 2004). The programmes were fundamentally top down, with little involvement of local beneficiaries. Moreover, the programs focused on promoting conservation practices on community lands, with minimal consideration given to individual farms. During this period, it was normal to follow any technical guideline developed and tested elsewhere without integrating it into the local socio- economical or environmental conditions (Shiferaw and Holden, 2002).

Despite the rich indigenous knowledge of soil conservation throughout Ethiopia, the FFW based soil conservation programmes were aimed at promoting “new” or “improved” soil conservation practices, which were based on little prior research and scientific base. Nevertheless, the

achievements fell far below expectations and the country still loses a tremendous amount of fertile topsoil and the threat of land degradation is alarmingly broadening (Gebremedhin, 2004).

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

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

2.6. Household Food Security

2.6.1. Food Security Concept

Food Security is a concept that evolved over time. There are many definitions of food security (Hoddinot, 2002). The most widely used definition of food security is given as ‘...access by all people at all times to enough food for an active and healthy life (World Bank, 1986).The concept of food security is defined to include both physical and economic access to food that meets people’s dietary needs as well as the food preferences.

The essential elements of food security are the availability of food and the ability to acquire it. There are four core concepts implicit in the notion of “secure access to enough food at all times”. These are (a) access to enough food, defined by entitlement to produce, purchase, exchange food, or receive it as a gift. An individual's entitlement is rooted in his/her endowment - the initial resource bundle that is transferred via production and trade into food or commodities which can be exchanged for food (Maxwell, 2003) (b) Sufficiency of food, defined mainly as the calories needed for an active and healthy life.

In this case, the definition is individual not household. Where household is aggregate of individuals in household whose food need has to be satisfied (c) security, defined by the balance between vulnerability, risk, and insurance. The notion of risk and risk avoidance have been central to definition of food security since the term came into use in the 1970s (d) time, where food insecurity can be chronic, transitory or seasonal.

In a broader way, Maxwell (2003) defines food security, as ‘...a country and people are food secure when their food system operates in such a way as to remove that there will not be enough to eat. In particular, food security will be achieved when the poor and vulnerable, particularly women and children and those living in marginal areas have secure access to the food they want...’ In the mid-1970s, food security was conceived as adequacy of food supply at global and national levels (Debebe, 1995). Attaining food self-sufficiency alone does not necessarily imply the achievement of food security. Because many countries those used to be considered as self-sufficient in food were found to be food insecure because they lack either an efficient food system or the capacity to the level of food entitlement. This indicates that attaining macro level food self-sufficiency does not ensure the achievement of household food security (Getahun,

2008). Therefore, food security strategy has to address household-level food production through investment in food production and storage..

2.6.2. Food Insecurity

Food insecurity has been described as a condition in which people lack basic food intake to provide them with the energy and nutrients for fully productive lives (FAO, 2003). The stages of food insecurity range from food secure situation to full-scale famine. Food insecurity can be categorized as either chronic or transitory. Chronic food insecurity translates into a high degree of vulnerability to famine and hunger (Albert, 2012).

Chronic hunger is not famine. It is similar to under nourishment and is related to poverty which exists in poor countries. Food insecure people are those individuals whose food intake falls below their minimum energy requirements. They also exhibit physical symptoms caused by energy and nutrients deficiencies resulting from inadequate or unbalanced diet (Albert, 2012).

2.6.3. Global Food Security Situation

Worldwide around 852 million people are chronically hungry due to extreme poverty, while up to 2 million people lack food security intermittently due to varying degree of poverty (FAO, 2001).Of the 39 countries worldwide that face food emergencies, 25 countries are found in Africa. Sub-Saharan Africa has the highest prevalence of under nourishment and has shown little progress in reducing this in the last 30 years.

Three quarters of the world's poor live in rural areas and earn their living from agriculture (FAO, 2003). In Africa, widespread and abject poverty and hunger are getting worse. Nearly half the population of Sub-Saharan Africa lives below the international poverty line, a higher percentage than in any other regions. Improving poor performance of Africa's stagnating agricultural sector

is the key to solving the problems of hunger and poverty since this sector is at the heart of food security (Albert, 20120). The International Food Policy Research Institute (IFPRI) in a 2001 report estimated that for each one percent rise in agricultural productivity, poverty would be reduced by 0.6 percent. Therefore, a direct relationship exists between agricultural productivity, food security and income.

In Ethiopia, 18.7% of the people live below the food poverty line (NBS, 2002). Food availability in rural areas depends on production; therefore if crop production fails due to unpredictable climate people in rural areas will suffer more than the urban people who depend on purchasing food (Aschalew, 2006). Poverty reduction is a major objective of economic development in Tanzania. Since independence in 1961 the government has been striving to eradicate poverty. Currently, the government introduced the National Strategy for Growth and Reduction of Poverty (NSGRP) which focus on attaining Tanzania Development Vision 2025 aiming at improving people's livelihood. More efforts will be directed to provision of social services as well as improvement of production sectors such as agriculture. The ultimate goal is to attain social well-being of the people, ensure food security and poverty reduction (Aschalew, 2006).

2.7. Food Security and Soil Conservation Management

As agreed, upon at the World Food Summit, (2004), food security is defined as —all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO, IFAD and WFP, 2015). A complete concept of food security includes four components, i.e. availability, stability, access and utilization (Aschalew, 2006). Availability implies that agricultural systems are capable of producing and distributing food to meet people's demand. Stability exists when there is no possibility for agricultural systems to suffer temporal or permanent risk of losing their capacity

to provide adequate food. Access ensures that people have enough monetary resources and traditional rights to acquire appropriate food. Utilization encompasses all food safety and quality aspects of nutrition.

Several studies provide the evidence that soil erosion threatens food security at the household, national and global levels (Lal, 2009). Soil erosion adversely affects food security in several ways. First, erosion-induced loss in soil productivity reduces crop yield, and therefore limits food availability to farmers as well as the nation. Second, limited farm incomes caused by crop yield loss prevent farmers from protein uptake and dietary diversity. Lack of protein in farmers' diet reduces their nutrition level. Third, erosion induced environmental pollution undermines national food and water safety. Toxic chemicals associated with erosion, such as heavy metals and pesticides, lead to contaminated food and water resources (FAO, IFAD and WFP 2015). Fourth, erosion generates sedimentation and pesticide into river, lake and ocean, which causes water pollution and reduces fishery supply. This will restrict people's access to fish as one of protein source, and therefore affect their nutrition level. Some factors can exacerbate or offset the adverse effects of soil erosion on food security, such as population growth, climate change, and technological progress and trade policies.

2.8. Conceptual Framework

In this part, households' food was analyzed by four pillars or components of food security; which is food availability, access to food, and food stability and food utilization with their indicators because it is a challenge to analyze food insecurity using specific or single indicator. In other words, household food security is multi-dimensional and has complex interaction with various indicators.

Conceptually, food security is defined as access by all people at all times to enough food for an active and healthy life which comprises food availability and food access through home production, purchase in the market or transfer. As it is repeatedly mentioned, food security at the household level is conditioned by a household own production and household members ability to purchase food of the right quality in the market place. Hence, it encompasses food access, availability and utilization.

Food availability addresses the household adequate supply of food and is determined by the level of home production, purchase in the market or food transfer. Food availability can be affected by disruptions of food production due to bio-physical related problems, poor access to productive resources and rapid population growth.

Food access refers to the way in which households acquire available food in different means. This include home production, purchase in the market, borrowing, gifts from relatives/friends, and provisions through relief systems or food aid. Access to food is depends on household's sources of income ventures and saving pattern, social capitals, access to road, and markets.

Food utilization is the way in which people utilized food. It is determined by a number of interrelated factors including eating habit, food preferences, the quality of the food and its method of preparation, food rationing, water supply, and the nutritional knowledge and health status of the household.

Extension service, Household Characteristics (gender, occupation/Income levels, education level, religion, age and marital status), Adoption of recommended farm inputs and practices and the level of adoption of soil conservation practices may affect the dependent variable which is the measure of Food security of a homestead.

Technology adoption tends to increase agricultural productivity, and agricultural productivity influence farmers tendency of market participation or commercialization, and finally, commercialization gives economic power for the farmers to adopt technology. Both increment in agricultural productivity and market participation in turn empower the farming households to buy food as a result improves dietary diversity.

Sex of the Household Head: In the researches of Krishna et al., (2008) and Eleni, (2008) male headed household heads have a higher chance to be involved in continued use of SC measures than female headed households because most women spent their time in domestic activities and responsibilities

Age of Household Farmer: According to Mulugeta et al., (2001) “young farmers are often expected to invest in soil conservation practices because they often more educated, and as a result, are more aware of soil erosion problems and solutions”, therefore age of household and adoption of SWC in general have inverse relationship.

Family Size: Physical conservation measures are labor intensive technologies. Studies conducted in Ethiopia indicated that, for installation of recommended physical conservation measures, about 70 and 50 person days per ha for soil and stone bunds, respectively, were estimated to be required (Wagayehu and Lars, 2003). Household size influences the decision of farmers to undertake the conservation measures. Household labor is the whole supplier of the required labor for undertaking the farming and soil and water conservation operation.

Farm Size: Different studies conducted in different parts of Ethiopia reported that conservation measures take 10-20% of cultivation land through embankment and ditches and land taken out of cultivation increases rapidly with increasing slope (Belay, 1992). This makes the benefit that will

be obtained from conserving the soil in small farms to be less likely to compensate for the decline in production due to physical conservation measures (Wagayehu and Lars, 2003).

Soil Conservation Activities: Primarily, conservation structures were introduced with the objectives of conserving, developing and rehabilitating degraded agricultural lands and as well increasing food security through increased food crop production (Adbacho, 1991). As a result, most of the conservation structures were practiced to protect soil erosion on the farmlands. Some widely used structural soil conservation measures are soil bund, fanyaju, bench terrace, stone bund, cut-off drain water way, crop rotation, inter cropping, agroforestry, grass strip, and compost making.

Slope of a Farm land: Slope of a field affects the rate and amount of soil loss from fields. This forces farmers to control or mitigate the impact of erosion on fields that are situated in steep slopes and hence slope influences the decision of farmers to undertake conservation measures. Babcock, (1998) observed frequent conservation practices installed on steeply sloping cultivation fields which reflect the desire of farmers to control soil loss from highly erodible soil.

Training of SC: Farmers who know nothing about a practice cannot be expected to adopt it unless they understand its expected costs and benefits. Accurate and timely information has a positive impact on farmers' conservation adoption decision. More informed farmers better assess the impact of soil erosion on long-term productivity of their farmland and adopt SWC practices that help to resolve the problem of soil degradation. Wagayehu, (2003) in his study indicated that if a farmer receives better information (training) from DAs, they will be willing to construct new SWC measures and to maintain the existing ones

Extension Service: Farmers who have closer contact with agricultural extension agents are expected to be aware of the severity and impact of natural resources degradation. Therefore, as Chomba, (2004) stated, extension services have positive effect on soil and water conservation practices. The research conducted by Bekele and Drake, (2003) in Ethiopia also indicated that, farmers who receives better information from agricultural extension agents will be agreeable to construct SWC practices

Education Status of Household Heads: Represent the level of formal schooling completed by the HH heads (Mulugeta, et al., 2001) and he founded that level of education has strong influences towards the adoption of any kind of technology, with the same manner, Krishna et al., (2008) and Fikru, (2009) indicate that, better education level of the HH heads has strong and positive relationship with their adoption of SWC because of their ability to find new information and their understanding of new technologies

Income: Increasing dependence on non-agricultural activities reduces the economic significance of soil erosion. This is because involvement in off-farm activities crowds out resources (time, labor, interest) required for installing and maintaining the SWC measures. Gould et al., (1989) found negative relation between proportion of off farm income and adoption of minimum tillage.

The adoption and use of soil and water conservation practices was conceptualized as the discussion determinants of soil and water conservation measure. Each category of factors hypothesized to influence one or more of the decision-making process components. Each component can be visualized as a major step in the decision to control erosion.

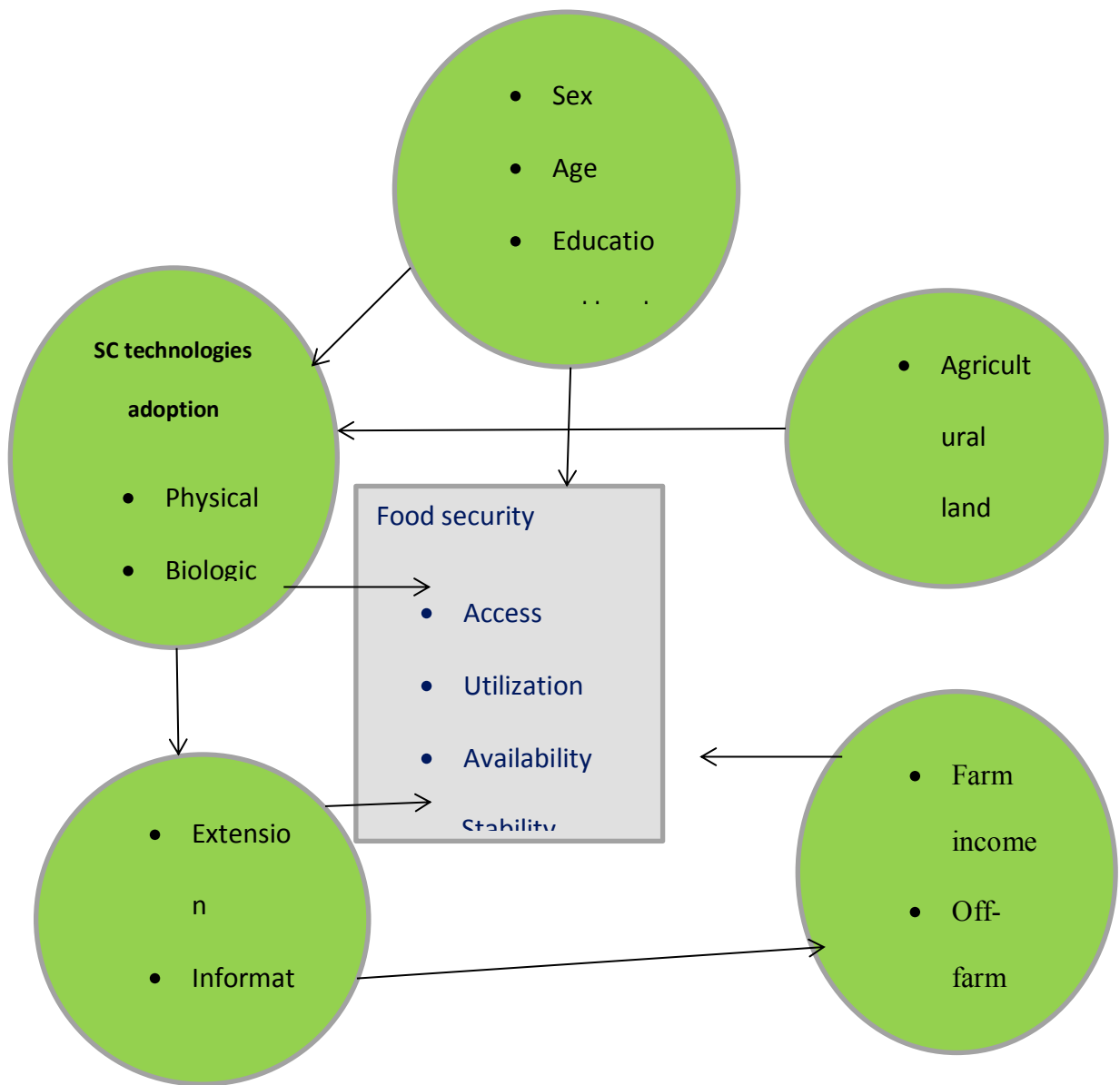


Figure 1: Conceptual Frame work Source: Own construction (2019)

CHAPTER THREE

3. MATERIAL AND METHODS

3.1. Description of the Study Area

3.1.1. Geographical Location

This study was conducted in Chenchaworeda. The woreda is one of the 15 woredas in Gamo Gofa Zone of SNNP region of Ethiopia. Astronomical location of the district is between $6^{\circ} 8' 55''$ and $6^{\circ} 25' 30''$ North Longitude and between $37^{\circ} 29' 57''$ to $37^{\circ} 39' 36''$ East Longitude. It is located about 521 km south of Addis Ababa the capital of Ethiopia and 36 km away from the zonal capital of Arba Minch. The district is subdivided into 45 rural kebeles and 5 transition towns. The woreda is bordered by four districts; Aribaminch Zuria in the south and southeast; Mirab Abaya in the east; Kucha in the North and Northwest; and Dita in the West.

3.1.2. Population of the Study Area

According to woreda Finance and Economic office estimation (2016), human total population was estimated that 154,701 from this 69,842 are male and 84,859 are females implying, 54.9% of women. The household head number was male 17,621 and female 6,113 total 23,734. The woreda has high population number per square kilo meter which estimated 434 persons/km². The people of woreda do not generally produce food for year round consumption even in a year considered to be normal climatically. This is due to over population, severe land degradation, land shortage and erratic rainfall. The sources of conflict in the woreda are Forest, Grazing land, Borderland and Waters are the major one. Reduced community access to resources are, the increase of population and decrease of land productivity.

3.1.3. Topography and climate of the Study Area

Topography of the highland plateaus especially, those are elevated above 2700 meters are dominated by hills. According to WANRO, the general classification of the area is about 65% mountainous, 13% plane, 5% gorges and 17% sloppy land features. In the district, the altitude range is between 1229- 3490 masl and the annual rainfall range is between 800 - 1400 mm. The minimum and maximum temperature ranges are 11⁰ to 13⁰C and 18⁰ to 23⁰C degree centigrade respectively. The area is divided in to two parts the midland, Woina Dega, whose altitude ranges between 1229 to 2700 masl has 18% coverage which contain 13 kebeles and the rest 82% covers by highlands Dega whose altitude is above 2700 masl which contains 32 kebeles.

3.1.4. Land Use Systems and Coverage of the Study Area

According to the woreda's Agriculture and Natural Resource Office, the total area of the district is estimated to be 37,360 hectares. The average land holding per household is estimated to be 0.35 hectare. The major land uses patterns are private holding (farming), communal (grazing) and forest land. The current land use coverage's are cultivation of annual crop is 58%, Perennial crop is 12% and grazing lands is 6.6%. Among the total area, 9.4% of the land is currently unutilized and the remaining (15%) is covered by shrub/bush and natural and plantation forests. The farming practice in the district is mixed farming systems which are crop production and livestock keeping. The major means of livelihood in the area are subsistence rain fed agriculture, traditional weaving and involvement in off-farm activities (Agriculture Office 2017).

3.1.5. Livelihood Zone

According to CSA data in (2007) the livelihood classification of the woreda; living standards have mainly divided in to four parts the lower class is the very poor households, next the poor household, then the middle and the higher class is the rich households.

According to CSA data in (2007) chenchaworeda was known by Gamo Gofa Enset and Barly Livelihood Zone (GGE). The woreda is mountainous and densely populated zone that includes the wet midland and highland agro-ecological zones of Gamo Gofa administrative zone. Arable land is at a premium and the poorer half of households operates on ¼ to ½ of hectare. They therefore have only a small margin for coping with the periodic production problem whether from inadequate/erratic rain fall, or crop pest. The enset and barely are complemented by wheat, sweet or Irish potatoes, horse beans and field-peas as food crops, together with some maize and haricot beans mainly consumed green. There is no specialized cash crop, and a limited capacity, even amongst the better-off, to sell food crops; and this often aimed at exchanging one food for another, e.g. pulses sold to buy maize.

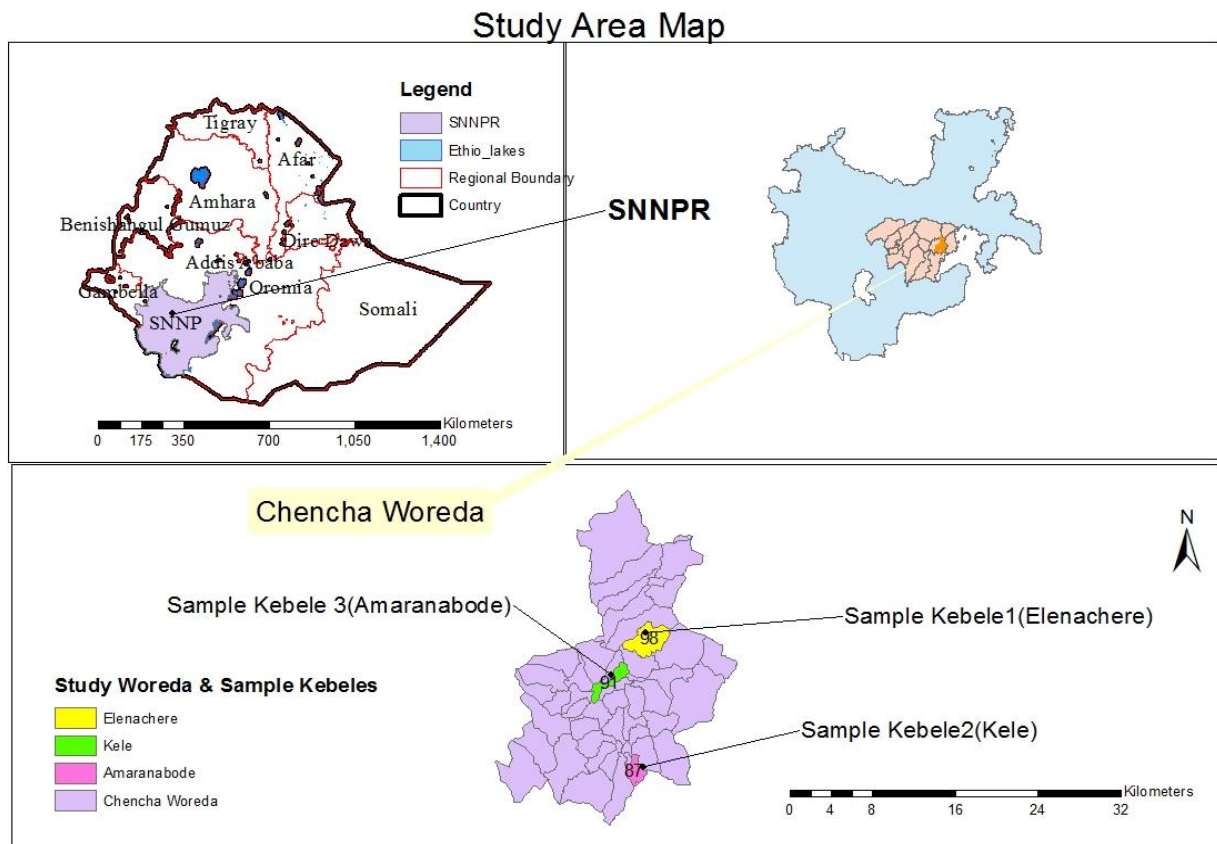


Figure 2: Map of the Study Area Source: Ethiopia Mapping Agency 2007 Shape file

3.2. Research Method

3.2.1. Research Design

The research design employed for this study was cross-sectional research design which incorporates both qualitative and quantitative survey method. The rationale behind the choice of this design was the short duration of the study which obliges the data was collected through one time survey. The design is useful for descriptive purposes as well as for determination of relationship between and among variables (Bailey, 1998).

The main survey instrument used for this study was interview questionnaires'. The use of the survey allowed the collections of large amount of data from large population in highly economic way as (Saunders et al 2009: 144) cited by (Diriba, 2013). In addition, the study used Focus Group discussion, Observation and secondary data as deemed necessary.

3.2.2. Data sources

Data for this study was captured from two sources: primary and secondary sources. The main primary sources of data were households. Hence, field observation, focus group discussion, interviews with selected households' farmers and other key informants' interview were primary data sources. Zonal and woreda agricultural experts, Kebeles administrators, soil and water conservation supervisors and DAs provided primary information. In addition, secondary sources of information used for this study. The secondary source data used for this study was written documents, published researches, books and other related sources.

3.2.3. Sampling Techniques

In this research, random sampling techniques were used. First, woreda was purposefully selected because of the researcher previous and current knowledge, access to get data's and understanding food security status of the study subjects. Secondly, the kebeles, (three sample kebeles, Kele, Elenachere and Amaran bodo) were selected by random sampling technique based on agro-climatic condition. Thirdly, sample households were selected based on systematic random sampling techniques because of homogeneity in agricultural practices and settlement arrangement, identical in topography, dressing and eating styles.

Hence, Kele and elenachere kebeles were chosen from dega and Amarana bodo were chosen from moist woina dega agro ecological zone. These three rural kebeles has a total household's head population of 900. Of which 691 were males and 209 were females. From these household's head populations Kele had 228 males and 69 females with a total of 297 household's head populations. While Elena chere had 246 males and 75 females with a total household's head population of 321 and Amaran bodo had 217 males and 65 females with a total household's head population of 282. Therefore, number of sample households head was 91 in Kele kebele, of which 70 were males and 21 were females and in Elena chere there are 98 samples household's head of which 75 were males and 23 were females and in Amarana bodo there are 87 samples household's head of which 67 were males and 20 were females. Totally, 276 sample households were selected from three kebeles through systematic random sampling techniques, of which 212 were males and 64 were females.

There were three focus groups. Each group had nine (9) members who were selected purposefully for the study. The information gathered through key informants' was used to harmonize and supplement the data collected from household survey through structured

questionnaire. Interview was conducted with (12) key informants (4) members from each kebele such as elder people who have had lived and worked for long time in the study area, kebele leaders, SC supervisors and Development Agents (DAs) and selected purposefully for the study.

3.2.4. Sampling Size Determination

To determine the sample size of the study area, this study was use Yamane's formula (1977) (cited in Israel, 1992), with 95 confidence levels. The reason for using formula is because this kind of formula is valid for survey researchers which compose large population. Moreover, the population under investigation is homogenous in its socio-economic and geographic context and the formula enables to get manageable sample size.

$$n = \frac{N}{1 + N(e)^2} = \frac{900}{1 + 900(0.05)^2} = \frac{2700}{7.75} = 276$$

n= sample size N= total population of the sample

e= acceptable error in social science.

3.2.5. Methods of Data collection

The researcher used both primary and secondary data sources. The primary data necessary for the study was collected by the researcher and other five voluntary development agent workers. The questions used pre-tested on selected respondents. Subsequently, on the basis of the results obtained from the pre-test, necessary modifications were made to the questions, which were used ultimately by translating from English into the local language. The data was collected from March – April, 2019. Primary data were collected using semi-structured questionnaire through formal interview method The questionnaire for household survey were included detailed

inquiries about household data such as age, sex, marital status, education level, livestock holding, family size, non-farm income, perception of SCs impacts, frequency of household contact with extension agents and food calorie intake.

Focus group discussion (FGD) was another most important data collection technique used to collect qualitative data by preparing discussion questions related to the relationship between implementation of farmers towards SC practices and food security situation of households. FGDs were held were selected model farmers of the sample kebeles heads, religious leaders, agriculture extension workers and SC supervisors.

3.2.6. Method of Data Analysis

Data analysis was undertaken by using Descriptive and Inferential Statistics like t-test, chi-square test, frequency and percentage. After we are being dead sure that the data have kept its quality, it was coded, summarized, managed and tabulated for the analysis.

T-test used to determine if there is a significant difference between the means of two groups, which may be related in certain features for continuous variables. Chi-square test also used to show degree of relationship between the food security status of farmers and the categorical explanatory variables such as sex, education status, and access to extension service, SC practice, farm income, crop yield, livestock ownership and off-farm activities.

Logistic regression model was employed to analyzed factors affecting food security status of households. Analysis was done using STATA version 22 software.

$$\text{Logit } IP(\text{outcome}) \ln \frac{p(\text{outcome})}{1-p(\text{outcome})} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots \epsilon_1$$

Where, p (outcome) is the probability of occurrence of food security, 1- p (outcome) is the probability of none occurrence of food security, β_0 , β_1 , β_2 and β_3 estimate regression

coefficient, x_1 , x_2 and x_3 are explanatory variables and ε is error terms, which included in the model.

While, for this study by considering the given explanatory variables the logistic regression equation has been formulated as follows.

$$\text{Logit } [P(FS)] = \beta_0 + \beta_1(\text{EXS}) + \beta_2 (\text{IN}) + \beta_3 (\text{Ed}) + \beta_4 (\text{Ag}) + \beta_4 (\text{SL}) + \beta_5 (\text{CY}) + \beta_6 (\text{SC}) + \dots + \varepsilon_i$$

Where,

FS = Food security

EXS = Extension services

IN = Income

SL = Farm slope

CY = Crop yield

SC = soil conservation practices

Furthermore, data collected through key informant interviews and focus group discussions was analyzed using textual and tabular analysis. Using SPSS software for data analysis, in each sample collected from different Agro ecological zone will be compared to get the food security status of household, a modified form of a simple equation termed as Household Food Balance Model, originally adapted by Degefa (1996) from FAO Regional Food Balance Model and thenceforth used by different researchers in this field (Mesay, 2009) was used to calculate the per capita food available which is $GP + GB + FA + GG) - (HL + GU + GS + GV)$ Where,

NGA= Net grain available/year/household

GP= Total grain produced/year/household

GB= Total grain bought/year/household

FA= Quantity of food aid obtained/year/household

GG= Total grain obtained through gift or remittance/year/household

HL= Post harvest losses/year

GU=Quantity of grain reserved for seed/year/household

GS=Amount of grain sold/year/household

GV=Grain given to others within a year (Mesay, 2009).

The net grain available by sample households' calorie content was computed using calorie conversion table of EHNRI, (1968). Household members were also converting to their adult equivalent. Then, the amount of total calories available by each sample household was computed and divided by 365 days to get per day calorie available for household. The figure was divided to the Adult Equivalent (AE) of respective households, which finally was given the amount of calorie available per AE for each sampled household. Thus, those households greater than the minimum amount of calorie required (2100 kcal) is put under food secured otherwise not food secured (Hoddinott, 2001). The situation of household food security within soil conservation users and non-users is also seen independently.

In order to calculate rate of return to land management of crops grown by conservation practices users 2017/2018 production season, the cost of production and benefit were surveyed and calculated. Net return of per hectare is identified.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

This chapter mainly presents the findings of the study with an appropriate level of discussion. It is divided into two sub-headings that could give a brief account of the subjects that were being investigated by the study. The first sub-heading presents descriptive analysis of sample households. The second sub-heading is econometric model that analyzes food security status of SC adopter and non-adopter households

4.1. Descriptive analysis

In this section of analyses descriptive statistics such as mean, standard deviation, percentage, t-test and chi-square test were employed using STATA version 22 software. In this study, adopters of a technology refer to farmers who used SC practices and non-adopters are those farmers who do not use SC practices. According to food security standard a household who consumed or get more than 2100 kilo calorie is food secured and less than this amount is food insecure.

4.1.1. Descriptive analysis of soil conservation Practices on farmland in the study area

Table 1 describes SC practice of the sample households from this 49.84% of sample households used integrated soil conservation practice which shows this practice should be increased. Fanya juu is the other SC practice in the study area from this majority of (63%) households does practice this practice. Waterway especially vulnerable to erosion because of concentrated flows they need to accommodate. They should be carefully designed, constructed, stabilized and maintain to reduced risk of failure by gully and over topping. They are designed by taking into account the size of catchment area, soil type, land slope, land use and expected grass cover in

channel. Soil conservation water way usually relies on a lining of vegetation to give protection from erosion. Vegetation protects the channel by reducing the velocity near the bed and covering and binding the soil together. Water way is the important type of SC practice implemented in Chenchaworeda 62.7% of sample households actively involved in this practice.

Compost is the other modern soil fertility improvement measure introduced to the area. It has gaining more acceptances on the side of farmers. The preparation of compost involves the use of ash, leaves, grasses, cow dung, etc. Basically, there are two ways of preparation (this is on the basis of whether the compost is prepared on the surface or in the ground). Compost prepared on the surface is termed as 'heap'. The other which is prepared inside the ground by digging a hole is termed as 'pit' communication with the Woreda Expert. The difference lies in the place where it is processed and the amount of sunshine it receives. In the 'dega' agro-climatic areas, heap is a common way of compost preparation. But, in 'Wainadega' areas, 'pit' are commonly used since it is processed with in short period of time (around 3 months). Therefore, pit is a widely practiced method of preparing compost in the study area. In the study kebeles, this measure has been introduced very recently. However, in spite of its recentness, it has been widely adopted by farmers due to the relatively lower cost of the inputs.

Discussion with the key informant also further strengthens the idea that farmers have keen interest to prepare and apply compost. But, the major constraint which was raised in the discussion was the shortage of animal dung since the largest portion of it is used as source of fuel. Moreover, sometimes dung-cakes are also prepared for sale to the near-by urban areas. The same issue was raised in the discussion with regard to the use of manure on crop lands. Therefore, it can be concluded that compost as part of manure has got wider acceptance on the side farmers of the of the study area. It has been playing an important role in improving the

fertility level of crop lands which even ally helps to increase crop productivity. In the study area more than half of the sample households practically prepare and used compost for their farm.

The other crucial SC practice as well as efficient use of farm land is intercropping. Specially, intercropping of perennial crops with horticultural crops can generate additional food source and income for households. Even though the importance of intercropping is enormous only 16.3% of sample households applied this practice.

Crop rotation SC practices are practiced 79.1% of sample households applied this practice. Crop rotation has the capacity to improve the fertility status of the soil so as to resist to pest and plant disease (Yohannes et al, 2000). Crop rotation is traditionally practiced on farm plots located away from homesteads and dispersed each other. From the experts, it was further clarified that farmers' choice of crops to cultivate in rotation largely depends on the interest of the farmers and type of soil conducive for crops. The main crops involved in the rotation system are cereals, legumes and less commonly oilseeds.

Traditionally, farmers practice this system on their croplands. However, they have failed to provide proper justification for their practice. They are also knowledgeable about the relationship between crops and soil types. The evidence is that farmers during the discussion have indicated the idea that some types of crops greatly affect the soils of their plots which in turn affect the potential of the soils to grow certain types of crops. It implies that farmers in the study area have the awareness on the fact that some crops use certain kind of mineral nutrients in the soil to a larger extent while others do not.

Table 1 Soil Conservation practices applied in the study area

Variable	Frequency	Percent
Integrated soil conservation		
No	115	41,7
Yes	161	58.3
Fanya juu		
No	102	37
Yes	174	63
Water way		
No	103	37.3
Yes	173	62.7
Compost preparation		
No	78	28.3
Yes	198	71,7
Agroforestry		
No	231	83.7
Yes	45	16.3
Intercropping		
No	230	83.3
Yes	46	16.7
Crop rotation		
No	210	79.1
Yes	66	23.9

Source: own survey (2019)

4.1.2. Chi-square test for soil conservation practices

Adoption of physical Soil conservation Methods

From the selected physical conservation methods fanyajuu was the most important and significant variable relative to adopters or users of soil conservation methods. There was also significant difference between adopters and non-adopters on soil bund practice.

Table 2 Chi square test of use of physical conservation methods

Percentage SC adopters				
	No	Yes	χ^2	P Value
Water way				
No	53	49		
Yes	31	142	8.0456	0.031
Fanya juu				
Very Effective	0	36		
Moderate effective	28	109	11.46	0.002
Less Effective	28	77		

Source: own survey (2019)

Adoption of biological soil conservation methods

There was positive association between food security and biological soil conservation methods such as crop rotation and using agroforestry in homestead area. Chi square test reveals that crop rotation and using agroforestry were the most important biological soil conservation practices which are highly significant at 1% significant level.

Table 3 Chi square test for use of biological soil conservation methods

Percentage SC adopters				
	No	Yes	χ^2	P-Value
Crop rotation				
Very Effective	0	36		
More Effective	27	109	11.46	0.003
Less Effective	27	77		
<u>Agroforestry</u>				
Very Effective	4	20		
Moderate effective	14	110	11.48	0.003
Less Effective	36	92		

Source: own survey (2019)

4.1.3. T - Test distribution of household heads characteristics and adoption of soil conservation practices

Household age is one of the most important demographic characteristics for farmers' adoption of SC practices. The awareness about soil erosion and controlling mechanisms is influenced by age. There was a difference in age between adopters and non-adopters of SC practices. The mean age of the non-adopters were about (45.9882) whereas the adopters were about (41.3927) years (Table: 4). the mean age of adopter were younger than non-adopter and this shows that young household heads were more likely to adopt SC measures than adult.

The analysis of the T - test show that at 1% level of significance indicated that, there was a strong significance relationship between age and adoption of SC practices. The result obtained from the FGD and in-depth interview explained that young farmers had better experience in the adoption of SC practices than elder age group.

Family size is the other major factor that played a crucial role in the adoption of soil conservation practices. The mean household family size of non-adopters and adopters of SC practices were (6.2941) and (4.9686) respectively (Table: 4). Thus, it can be concluded that the non-adopters had relatively larger family size than adopters.

The t-test finding depicted that, the respondent family size is statistically significant at 5% of level of significance. Family size of household members has strong relationship with the adoption of SC practices. Households with small number of family size were less likely to adopt SC measures than households with more family size.

Table 4 indicates that the mean size of farm land owned by the non-adopter and adopter were 0.4798 and 0.4798 hectare respectively. The t-test analysis at 1% level of significance depicted

that, there was strong significant relationship between adoption of SC measures and farm size. That means adoption of soil conservation structure was influenced by the size of farm lands. Farmers having smaller farm size were more likely to remove conservation structures totally or temporarily. This was because farmers who had smaller farm land were lacks the required training to maintain the structures. This was also supported by Tesfaye, et al., 2013 concluded that farmers who had large farm size showed interest to invest on SWC measures.

Results in Table 4 indicate that the non-adopter of the households (30.79%) had mean off-farm income of 1708.2357 birr per year, and the mean of adopters (69.21%) had off-farm income of 2320.4712 birr per year. The t-test analysis at 5% level of significance depicted that, there was significant relationship between adoption of SC measures and off-farm income of the respondents.

Table 4 indicates that the Calorie per adult equivalent per day of the non-adopter and adopter were 1695.6200 and 2835.5921 kilocalorie respectively. The t-test analysis at 1% level of significance showed that, there was strong significant relationship between adoption of SC measures and Calorie per adult equivalent per day. That means adoption of soil conservation structure was influenced by the Calorie per adult equivalent per day.

Table 4 T-test distribution of variables by SC technology adoption status

Variable	Mean (Non-adopter)	Mean (Adopter)	T - value
Age	45.9882	41.3927	0.002
Farm size	0.1979	0.4798	0.000
Family size	6.2941	4.9686	0.03
Off-farm income	1708.2357	2320.4712	0.051
Calorie per adult equivalent per day	1695.6200	2835.5921	0.000
Family lab our	1,5059	1.4889	0.861

4.1.4. Chi-square distribution of household heads in terms of adoption status

The total numbers of sample households used for this study were 276. They were categorized into non- adopters 85 (30.79%) and adopters 191 (69.21%). From the below sampled households, 211 (76.4%) were male and 65 (24.6%) were female household heads (Table 5).

Based on the survey, 75% of the adopters were male headed households and 27% were female household heads. On the other hand, out of the non-adopters 56% were male and 44% were female headed households. Chi-square tests at 1% of level of significance were taken to understand the degree of association between sex and adoption of SC practices. Accordingly, there was significant relationship between adoption of SC practices and household head sex. According to focus group discussion there were limited participation of women in the adoption of SC practices and had limited access to information. They were highly involved in regular household activities than men. Eleni, 2008 and Krishna et al., (2008) in their research stated that, male household heads had more chances to involve in SWC practices than female household heads. This is because most women in the study area spent their time in domestic responsibilities and activities.

Education is one of the socio-economic characteristics of household heads playing a significant role to ensure farmers' awareness and appropriately use information to adopt SC measures. In the study area sample respondents were categorized into illiterate, primary, secondary school and above secondary based on their educational background. Consequently, from the total number of respondents, 57% were literate who can read and write while 43% were illiterate (who cannot read and write). Hypothetically, educational status was directly related with the adoption of SC practices. Because literate farmers were in better condition to get information and properly use it. However (Table 5) indicated that, there is significant difference between educational status and SC practices of adopters and non-adopters.

The chi-square analysis for educational status of sample households and SC practices between the two groups was found to be insignificant at 1% level of significance. As a result, there was association between the educational status of household heads and the adoption of SC practices.

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

Table 5 forwarded that, 69.2% of the respondents contacted with extension service workers but, 30.8% of farmers did not. From the adopter respondents 84.7% have access to extension services. On the other hand, only 39% of the non-adopters got extension service. This implies

that, if farmers did not have enough amount of contact with extension service workers, they might not have adopted SC practices.

The chi-square test at 1% level significant indicates that access to extension services had significant influence on the adoption of SC practices. The finding was similar with the study of Desta (2012) stated that extension services have a positive effect on SWC practices.

Slope of farm land is another physical component that determines the adoption of SC measures by household farmers. The survey result indicated that (49%) and (40%) of the respondents were postulated as they had gentle and steep sloping farm land (Table 5).

The large number of the adopters'' (61%) farm lands was found along gentle, (32%) steep slope and areas which need much attention and only 7% were found flat area. On the other hand (74.5%) of the non-adopters sample HH farm lands were found along steep slope, (19%) gentle (22.5) and only (3%) under flat slope areas that needs relatively less attention than adopters for constructing SC structures.

The chi square test result indicates that, the respondents land slope was significant at 1% of significant level. From this point of view the farmers who had farm land at gentle and steep slope understand the impact of soil erosion on their farm land. As a result, farmers decided to construct SC structure on their farm land. The slopes of topography determine farmers'' behavior by influencing the tendency and velocity of runoff, which in turn affected the economic importance of soil erosion, thus reducing the output of the cultivated land.

Table 5 Chi-square distribution of variables by SC technology adoption status

Variables	Categories	% of sample proportion	Percentage distribution		Chi square test
			No-Adopters	Adopters	
Sex	Female	23.2	57.8	42.2	0.001
	Male	76.8	17	83	
Education	Illiterate	43.1	50	69	0.04
	literate	56.9	35	122	
farm plot slope	Flat	4.7	7.7	92.3	0.000
	Gentle	49.3	14	86	
	steep	46	51.2	48.8	
extension service	No access	40.9	46	17.5	0.000
	Access	59.1	54	82.5	
Marital status	Not married	1.8	3.6	1.1	0.357
	Married	73.5	74	73.3	
	Divorced	10.2	5.9	12	
	Widowed	14.5	16.5	3.6	

Source: own survey (2019)

4.1.5. Food security status and adoption of SC technology of the households

The distinction between food secured and in-secured households depends on calorie intake per adult equivalent per day. According to international standard of food security measure 99(35.8%) of households were food in-secured and the remaining 177(64.13%) were secured households. (Appendix 7.4).

Table 6 also describes association of soil conservation practice with food security. 91.5% of households who adopt SC practice were food secured only the remaining 8.5% were not adopted SC practice on their farm. 69.7 % of in-secured households were not adopted SC practice and 30.3% of in-secured households were adopted SC practice which shows the advantage of SC practice to increase productivity by this to be food secured. The result indicates significant difference between secured and in-secured households.

Table 6 Chi-square test of food security status and adoption of soil conservation practices

Categories		% of sample proportion	Percentage distribution		Chi square test
			Non-Adopters	Adopters	
Food security status	In-secured	35.9	69.7	30.3	0.000
	secured	64.1	8.5	91.5	

Source: own survey (2019)

4.1.6. Descriptive statistics for socioeconomic variables and food security in the study

A combination of different descriptive, the means and standard deviation and inferential, the t-test and X²-test, statistics for explanatory variables of sample households were performed on the household level data to inform the subsequent empirical data analysis. The descriptive and inferential results presented on Table 3 show that there was statistically significant difference between secured and insecure in terms of Age, farm size in hectare, farm income.

As discussed above there was significant difference between secured and in-secured households at 1% significant level. The observed variation in household income could be due to the fact that farmers in high altitude areas grow cash crops (I. potato, Wheat, Apples) and keep dairy cattle while the farmers in low altitude mostly grow annual crops such as sweet potato, wheat and beans. Farmers in low altitude areas mainly produce food crops which are used for home consumption and little surplus for the market. This has impact on the implementation of SC practices due to the fact that income has a bearing on investment and adoption of soil conservation innovations. High income increases risk aversion behavior among farmers. These findings are in line with those of Tiffen (2003) who observed that economic factor promotes adoption of agricultural technologies. Increase in overall income may affect land use decisions taken by a farmer. High income enables farmers to expand the farm for agricultural production. The ability of the farmer to invest in agricultural production depends on the income obtained from the farm. Gebremedhin and Swinton, (2004) observed that willingness of the farmer to invest in soil improvement activities is closely associated with the overall economic profitability of farming.

Table 7 Descriptive statistics of continuous independent variables

Variable	Mean across food security status		t-test	P value
	Secured	In-secured		
Age (years)	43.84	46.09	1.68	0.09*
Farm size in ha.	0.28	0.22	2.01	0.04**
Off-Farm Income	2317.23	1914.14	2.75	0.006***
Farm distance in km	1.36	1.34	0.28	0.77
Family Labor	2.61	2.54	0.71	0.47
Family Size	6.89	6.79	0.46	0.64

Source: own survey,

The descriptive and inferential statistics results presented in Table 8 show that unexpectedly 84.85% of in-secured households were male headed households and the remaining 15.15% were female headed households but from female headed households 72.32% were food secured from this observation chi2 test show that compared to female headed households male headed households were food insecure. This suggests that the majority of the households in the study area are male headed. According to Addisu, (2011) in most cases males are the ones who make major decisions such as use of income despite of the fact that women contribute significantly to agricultural production.

Regarding to education level most of food secured households were educated better compared to in-secure sample households and the test showed that there was significant difference between them. 44.44% secured and 6.21% in-secured households use physical soil conservation to curb soil erosion and this variable had significant effect on food security. There is general

understanding educated farmers can easily adopt new innovations and access information and services. The study by Tesfaye et al. (2013) in southern region revealed that education influenced implementation of soil and water conservation measures. Low education level can be a barrier for agricultural development, since education normally has a significant influence on household's income strategies, land management and labor use (Tadele et, al 2014). The study by Glover (2005) revealed that adoption of technologies increased with the education level of the farm household head. Johansson, et al. (2009) also observed that education correlates positively with the adoption of SC measures. It is generally agreeable that access to information sources and communication channels may increase awareness about the effects and consequences of sustainable soil conservation practices among farmers.

It was since 1980s where SWC methods introduced in the study area. These measures can be categorized into three based on the land use type in which they were applied. These are conservation measures on farmlands, conservation measures on hillsides and conservation measures on degraded lands (to rehabilitate gullies). Most of soil conservation effort made in the area was directed in controlling soil loss from cultivated fields. Many of soil and water conservation measures introduced to the area are mechanical conservation measures. These include Contour farming, water way/ cutoff drain and fanya-juu. However, it is not usual to see stone bunds or stone faced bunds due to scarcity of stone, which is attributable to geological feature of the study area. It is only in few places that terraces are constructed in the study area. The biological measures introduced in the area were grass strips, Agroforestry, and Crop rotation and area closure. According to the chi2 analysis the sample households expected that soil conservation practice will reduce soil erosion, increase soil fertility and enhances crop yield. In the study area 86.44% of food secured and 81.82% of in-secured households got extension

The other part of Table 8 discusses Percentage of soil conservation practice rating in the study. According to the result soil erosion control, crop productivity and fertility of the soil rating was significant by the same amount 83.33% for those households who replied positively and the remaining 16.67% replied that SC practice does not have any effect for the above three mentioned variables. This result shows there was significant difference between them.

Table 8 Descriptive statistics of Dummy/ discrete Independent Variables (χ^2 test)

Percentage of food security status				
	In-secured	Secured	χ^2	P value
Sex				
Male	84.85	27.68	5.6	0.018
Female	15.15	72.32		
Education				
No formal education	72.73	27.12	65.11	0.000
Primary School	27.27	41.24		
Secondary School	0	28.25		
Above Secondary	0	3.39		
Marital Status				
Not Married	0	4	4.03	0.258
Married	77	127		
Divorced	7	21		
Widowed	15	25		
Biological soil cons.				
Yes	66.67	96.05	44.21	0.000
No	33.33	3.95		
Physical soil conservation.				
Yes	6.21	44.44	58.15	0.000
No	93.79	55.56		
Expected result				
Reduced soil erosion	8.08	11.30	10.6	0.032
Increase soil fertility	4.04	0		
increase crop yield	33.33	33.33		
All	51.52	54.80		
Not used	3.03	0.56		
Percentage of soil conservation practice rating in the study area				
soil erosion control	Yes	No	Chi2	P
Increased	83.33	68.52	6.05	0.014
No change	16.67	31.48		
Crop productivity			6.05	0.014
Increased	83.33	68.52		
No change	16.67	31.48		
Fertility				
Yes	83.33	68.52	6.05	0.014
No	16.67	31.48		

Source: own survey (2019)

Table 9 describes the difference between land ownership and slope of the land between food secured and in-secured households. Regarding source of land most of the land was owned but there was no significant difference between the two groups. Slope is an indicator of the likelihood of erosion on the land. The slope of a plot also affects the adoption of conservation structures because the steeper the slope, the more likely the land will be exposed to erosion. Hence, it is believed that adoption of physical structures tends to be likely on steeper slopes.

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

Table 9 indicates that out of food secured sample respondents (41.24%) of sample respondents farm plot is located steep slope “Denba gade” and about (51.41%) found in gentle “Lade gade” and the rest (7.34%) farm plot located on flat “Zuma gade” slopes. This shows that the majority of food secured sample respondent’s farm plot is found on gentle to steep slope which is susceptible to erosion. On the other hand more than 60% of food in-secured households land was located on steep slope which is highly exposed for soil erosion. Teklu and Gezahegn, (2003) in the southern region found that the slope of a plot to be one of the factors significantly influencing the adoption of soil conservation. Their results suggest that a farmer who operates a field with steeper slope is more likely to adopt the soil conservation technology. Wagayehu and Drake (2003) also found similar results. He argued the returns from investment on steep sloped plots might be low, hence less adoption on such plots. However, in the present particular study, the result indicates that slope of a plot has been identified as a major factor that influenced farmers’ adoption of soil conservation methods positively and significantly.

According to Woreda Agriculture and Livestock Development Office report (DALDO, 2008) Woreda has a total of 45 kebeles and all have extension workers. The study area all kebeles have extension workers. According to agriculture policy (Moa, 2005) each kebele in Ethiopia is supposed to have an extension worker. Based on the agriculture staff available in the Woreda there is only a deficit of 3 kebeles extension workers. Different strategies should be employed to ensure that extension packages reach most farmers. There is a direct link between extension services and implementation of SC technologies. The study by Teklu and Gezahegn (2004) suggests that majority of households who implemented SC measures had close contacts with extension agents. Extension services are major source of technical information for farmers. Lambin et al. (2003) observed that most of the farmers lack information and encouragement to change their traditional cultivation systems. In most cases there are gaps in knowledge and often research findings, projects and extension services fail to reach the majority. Based on the chi2 analysis there was significant difference between secured and in-secured households which implies those secured households have better extension contact relative to in-secured households.

Table 9 χ^2 Test for source of land and Slope

Percentage of food security status				
	In-secured	Secured	χ^2	P
Source of land				
Own land	79.80	79.66	3.72	0.155
Shared	12.12	6.78		
Rented In	8.08	13.56		
Slope				
Flat	3.03	7.34	10.103	0.006
Gentle 1-10%	36.36	51.41		
Steep slope above 10%	60.61	41.24		
Access Extension service				
No	21.21	11.86	4.29	0.038
Yes	78.79	88.14		

Source own survey (2019)

4.1.7. Coping strategies used by farmers to overcome food shortages

Different coping strategies used by farmers were identified. These include Sell of animals, Off-farm employment, Sell of asset, and reducing the number of meals per day.

Results in Table 10 indicate that 61.62% of in-secured and 43.5% secured households participated on Off-farm employment to supplement whatever little is obtained from their fields, whereas 32.32% of in-secured and 44.63% of secured households of households indicate that's selling of animals such as sheep, poultry and bee honey used for coping mechanism. Only 5.05% of in-secured and 9.04% secured sample households reduced the number of meal per day. Very small proportion both households forced to sell of asset and there was significant difference between the two categories in terms of coping strategy. The other important variable is months which households face series food shortage. Majority both secured and in-secured households face series food shortage for six months in the year.

Table 10 Months with series food shortage and households coping for food shortage

Coping strategy	Insecure	Secured	χ^2	Pr.value
sell of animals	32.32	44.63		
reducing meal	5.05	9.04	8.84	0.031
off-farm employments	61.62	43.50		
sell of asset	1.01	2.82		
Months with series food shortage				
3 months	25.25	29.38		
6 months	55.56	49.72		
7 months	0.00	3.95	5.04	0.28
9 months	13.13	12.43		
12 months	6.06	4.52		

Source: own survey (2019)

4.2. Econometric Analysis

4.2.1. Logistic regression analysis of the food security

Regression is concerned with describing and evaluating the relationship between dependent variable and independent variables on which the outcome variable depends on. Thus, this study tries to use binary logistic regression analysis to show the effect of determinant factors over food security.

Logistic regression used in study to predict a categorical (usually dichotomous) variable from a set of predictor variables to test age, sex, slope, crop yield, annual income, use of soil conservation method, access extension service, use of physical conservation method, expected result, labor, livestock ownership and access to credit with a categorical dependent variable food security, discriminant function analysis is usually employed if all of the predictors are continuous and nicely distributed; logit analysis was usually employed if all of the predictors are categorical; and logistic regression is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not nicely distributed (logistic regression makes no assumptions about the distributions of the predictor variables). For a logistic regression, the predicted dependent variable is a function of the probability that a particular subject will be in one of the categories.

Marginal effects after logit

$$\begin{aligned} y &= \text{Pr (food security status) (predict)} \\ &= 0.67816575 \end{aligned}$$

Table 11 Marginal effect after logistic regression of food security status

variable	dy/dx	Std.Err.	Z	P>z	[95%	C.I.
age	-0.008	0.004	-2.170	0.030**	-0.014	-0.001	44.649
sex*	0.322	0.056	5.730	0.000***	-0.432	-0.212	0.768
slope	-0.097	0.064	-1.500	0.132	-0.223	0.029	2.424
Education	0.326	0.047	6.880	0.000	0.234	-0.421	1.879
Yield crop	0.093	0.050	1.870	0.061*	-0.190	0.004	2.899
Farm income	0.030	0.000	2.200	0.028**	0.000	0.000	2172.640
Use soil cons*	0.316	0.135	-2.330	0.020**	-0.581	-0.051	0.804
Off farm*	0.021	0.087	0.240	0.808	-0.149	0.191	0.768
Access extension	0.220	0.097	2.270	0.023**	0.030	0.409	1.848
Biological SC	0.292	0.128	2.290	0.022**	0.042	0.543	1.855
Use physical SC	0.703	0.252	-2.790	0.005***	-1.196	-0.209	1.199
Credit service	0.081	0.077	1.040	0.297	-0.071	0.232	1.297
labor	0.055	0.046	1.190	0.236	-0.036	0.145	1.493
Livestock	0.045	0.041	1.070	0.283	-0.037	0.126	2.304

(*) dy/dx is for discrete change of dummy variable from 0 to 1

*** $p < .01$, ** $p < .05$, * $p < .1$. Source: own survey (2019)

Age of house hold (AGEHH): Age of the household was found to be negatively associated with being food secured and statistically significant at 5%. This can be explained by the fact that older farmers' income generating potential and SC practice is less relative to youths. This implies that youths have higher personal preference which can reduce the impact of soil erosion through the implementation of long term soil conserving structures and being food secured.

Sex of household head (SEXHH): Sex of a house hold head is one of the determinants of improved technologies adoption. As the logit model indicates sex of household head had positive and significant influence on the adoption of improved technologies at 1% significance level (Table 9). This shows that being male headed households have better access to information on SC variety and are more likely to be food secured than female headed households. Yenealem (2013) through his binary logit model results revealed that the adoption of improved maize variety is biased by gender, where female headed households adopt the improved varieties less.

Education (EDUCLVLHH): Having formal education improves the decision making power of a household to engage or not in activities especial externally driven interventions. In other word, education influences farmer's decision to adopt technologies by enhancing farmer's ability to adapt to it. In this study result, education was found to affect continued use of soil and water conservation technologies positively at 1% significance level and increase the probability of being food secured by a factor of per additional year of education. The positive association shows that better educated households seem to decide to retain conservation structures better than low level of the uneducated household. This implies that education may enable farmers to easily understand and recognize the problem of soil erosion, able to change and put into practice the knowledge and skill they obtained from extension services and other sources by this they can increase yield of crops and being food secured. Study is in line with the finding of Belete (2018) observed that education correlates positively with the adoption of SC measures.

Yield of crop: From the given sample household the yield of the cultivated crop significantly differs between food secured and in-secured households. There was positive association between the dependent variable food security status and this variable. Mean that when yield of the crop increases through use of improved SC practices and other factors the probability of being food secured will increase by 9.3% and it was significant at 10% significant level.

Farm income (FRMINCOM): Amount of farm income obtained within a year was one explanatory variable in this analysis. It is assumed those farmers who have more farm income more likely to be food secured than less income gainer households. It is significant estimated coefficient at 5% for this variable from the logit regression, giving evidence that shows farm income is one among the possible factors in influencing the to be food secured, ceteris paribus.

Access to extension (ACCEXN): Extension service plays a great role in enhancing awareness about SC practices and the possibility of a farmer to decide to practice SC activities. As the households get extension service, the possibility of the farmer to practice SC and to adopt new technologies increase by these farmers can produce more output and being food secured. Agricultural extension service in the study area has been mainly given by government organization (Office of Woreda Agriculture and Rural Development) and development agent (DAs) of the peasant association. In this study access to extension service was significantly affect to be food secured or not. Logistic regression show that the variable was 5% significant means compared to food in-secured households, if a household gets access to extension the probability of being food secured will increased by 22%.

Use of soil conservation measures (USESCMSRS): Soil conservation in Ethiopia is considered today to be of top priority, not only to maintain and improve agricultural production but also to achieve food self-sufficiency, which is the long-term objective of the agricultural development program. In this study those farmers who used SC practices are better off and food secured compared in-secured households. There was significant difference between secured and in-secured households in terms of use of SC measures and there was positive correlation between the dependent variable and this variable. The significant level was at 5%.

Biological SC (BIOLGSCM): Biological measures for soil and water conservation work by their protective impact on the vegetation cover. A dense vegetation cover prevents splash, erosion, reduces the velocity of surface runoff, facilitates accumulation of soil particles, increases surface roughness which reduces runoff and increases infiltration, the roots and organic matter stabilize the soil aggregates and increase infiltration. These effects entail a low soil erosion rate compared with an uncovered soil which shows in general a high soil erosion rate.

Even cultivated crops in agricultural areas are a better protection against soil loss than uncovered soil (relatively high soil erosion rate). Thus, biological measures are an effective method of soil and water conservation, especially since they are low in cost. Due to the above advantage of biological soil conservation methods, the productivity of the soil will increase and within small plot of land farmers can get better produce and be food secured. Similar scenario was observed when farmers use this practice the probability of being food secured increased by 29.2% and logistic regression showed that it was significant at 5% significant level. The finding by Tolera (2011) revealed that traditional biological land management practices have a significant role in improving cropland and biomass productivity based on its impact on soil quality and by this increase the probability of food security.

Physical SC (PHYSCM): Physical measures are structures built for soil and water conservation. Some principles should be considered. They should aim to increase the time of concentration of runoff, thereby allowing more of it to infiltrate into the soil, divide a long slope into several short ones and thereby reducing amount and velocity of surface runoff, reduce the velocity of the surface runoff and protect against damage due to excessive runoff. These physical measures can production and productivity of small holders' farm and increase the probability being food secured. In this study like biological measures, physical measures have positive relationship with the probability of being food secured. When a household applies physical conservation methods the probability of being food secured will increased by 70.3% and it was significant by 1% significant level.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Summary and Conclusion

This study was conducted to identify implication of soil conservation technology adoption and household food security status of farming households; and also to examine determinants of technology adoption and level of food security of rural farming households in Chench Wereda, Gamogofa Zone southern Ethiopia. Out of the total respondents, 69.21% of them adopted soil conservation technology while 30.79% of did not. The calculated Calorie per adult equivalent per day 35.8% of households were food in-secured and the remaining 64.13%) were secured households..

The t- test showed that there was a significant difference between adopters and non-adopters in terms of household age, farm size, family size, off-farm income, Calorie per adult equivalent per day. The chi-square test also revealed a significant difference between adopters and non-adopters in terms of sex, education, farm slope, extension service, marital status.

Chi square test also reveals that crop rotation and using agroforestry were the most important biological soil conservation practices which are highly significant at 1% significant level. From the selected physical conservation methods fanyajuu and water way was the most important and significant variable relative to adopters or users of soil conservation methods. There was statistically significant difference between secured and insecure in terms socio-economic characteristics such as age, farm size in hectare, farm income, sex education farm slope, access to extension service.

The adopted soil conservation measures contributed in increasing farm productivity through retaining moisture content of soil and are effective in restoration of vegetation in the area. And farmers who used SC practices are better off and food secured compared in-secured households. The young age have higher personal preference which can reduce the impact of soil erosion through the implementation of long term soil conserving structures and being food secured.

Male headed households have better access to information on technology and are more likely to be food secured than female headed households. And also farmers who have more farm income more likely to be food secured than less income gainer households

Farm size also exhibited a positive relationship with technology adoption. This is due to the fact that farmers with large farm size are likely to adopt a new technology as they can afford to devote part of their land to try new technology unlike those with less farm size.

Extension service plays a great role in enhancing awareness about SC practices and the possibility of a farmer to decide to practices SC activities. As the households get extension service, the possibility of the farmer to practice SC and to adopt new technologies increase by these farmers can produce more output and being food secured. Therefore, access to information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time.

From the result concluded that variables such as sex, crop productivity, off-farm income, off-farm income, access to extension service, physical and biological soil conservation practices were found to have positive effect on food security while age showed negative relationship with food security.

5.2. Recommendation

The following recommendations have been forwarded based on the results of the research.

- Adoption of soil conservation technologies has great impact on enhancement of farm productivity and alleviating food insecurity experience. Its multidimensional impact worthy of consideration to be incorporated in policy intervention by NGOs or government designed projects. It is evident that integrated and quality of SC technological dissemination has been insufficient in the study area. Therefore, above all, care taking institutes, especially BoA of Chenchawereda and WFP's should work extra hard to actualize integrated and quality of SC practices.
- Soil conservation technology adoption is affected by determining factors highly relate to information and asset possession like livestock holding and farm size. Information played great role on household's condition of technology adoption. Development agents of the woreda or other project officers should give maximum attention to dissemination of information about new technology at door.
- In some cases, even though households adopt soil conservation at the same time, their food security situation was greatly challenged by the number of people under their shelter. The issue of food security could not be solely dealt by farm activities so that family planning has to take its place. Even more, an opportunity of employment has to be created by the regional government as it helps in the battle with food insecurity. Therefore, bureau of family guidance together with woreda administration has to work closely.

6. REFERENCE

- Abebe, Y. and A. Bekele, (2014). The impact of soil and water conservation program on the income and productivity of farm households in Adama district, Ethiopia.
- Addisu D (2011). Benefits and challenges of adopting soil conservation techniques in Goromti Watershed, Central Ethiopia. MSc thesis. Addis Ababa University, Ethiopia.
- Adimassu, Z., A. Kessler and H. Hengsdijk, (2012). Exploring determinants of farmers' investments in land management in the Central Rift Valley of Ethiopia. *Applied Geogr.*, 35: 191-198.
- Adimassu, Z., B. Gorfu, D. Nigussie, J. Mowo and K. Hilemichael, (2013). Farmers' preference for soil and water conservation practices in Central Highlands of Ethiopia. 21: 101-118.
- African Development Bank (2014), Africa Food Security Brief: Special focus on climate Africa Food Security change Impacts. Statistics Department, Issue No 5, April 2014.
- Albert, S., (2012). Food Security for Africa: An Urgent Global Challenge. *Sasson Agriculture & Food Security 2012 New work*, FAO.
- Alemneh, D. (2003). Integrated natural resource management to enhance food security. The case for community-based approach in Ethiopia. Working Paper No. 16. FAO, Rome.
- Amsalu, A., and De Graaff, J. (2004). Farmers views of soil and water erosion problems and their conservation knowledge at Beressa watershed, central highlands of Ethiopia. *Agriculture and Human Values*.
- Aschalew , F.A., (2006), Determinants And Dimensions Of Household Food Insecurity In Dire Dawa City, Ethiopia.
- Ayalneh, D. (2003). Integrated national resources management to enhance food security. The case of community based approaches in Ethiopia, FAO, Rome, Italy 1-44
- Amsalu A, De-Graaff, J. (2007). Determinants of Adoption and Continued Use of Stone Terraces for Soil and Water Conservation in an Ethiopian Highland Watershed. *Journal of Ecological Economics*, 61(23):294-302.
- Belete L. (2018) Factors affecting adoption of soil and water conservation practices in the case of Damota watershed, Wolaita zone, Southern, Ethiopia Kerse Wolaita Sodo University, Ethiopia.
- Bekele, W, and Darke, L. (2003). Soil and water conservation decision behavior of subsistence farmers in the eastern highlands of Ethiopia a case study of the Hunde-Lafto area.

- Belay Tegene. (1998). Pedogenesis and Soil-geomorphic Relationships on the Piedmont Slopes of Wurgo Valley, Southern Welo, Ethiopia: SINET: Ethiop. J. Sci. 21(1): pp 91-111.
- Besha. T. (2003). Understanding farmers: Explaining soil and water conservation in Konso, Wolaita and Wello, Ethiopia. Tropical Resource management papers, No. 41. Wageningen, Netherlands: Wageningen University.
- Bewket, W. (2007). Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: Acceptance and adoption by farmers. Land Use Policy. 24: 44-51.
- Campbell J (1991). Land or Peasants? : The Dilemma Confronting Ethiopian Resource Conservation. African Affairs 90 (358): 5-21
- Central Statistic Authority, (2007). Ethiopian housing and population censuses program Addis Ababa, Ethiopia, October 2007.
- Chomba, G. (2004). Factors Affecting Smallholder Farmers, Adoption of Soil and Water Conservation Practices in Zambia. Unpublished Master Thesis, Michigan State University, Department of Agricultural Economics.
- Daniel, D. (2010). Sustainable land management technologies and approaches in Ethiopia. Natural resource management sector, MoARD, Addis Ababa, Ethiopia. Pp.1-321.
- Degefa Tolossa (1996). Belg crop production as a strategy of household food security: A comparative study of Belg Grower ab Non-Belg Farmers in Munessa woreda, Arsi zone. MA Thesis: Addise Ababa University.
- Dolan, T. (2006). Sustainable agriculture and rural development. A response to the realities of rural Africa. In: World Agro-forestry into the Future. (Edited by Garrity, D., Okono, A., Grayson, M. and Parrott, S). World Agroforestry Centre, Nairobi, Kenya
- . Douthwaite, (2001). Why Promising Technologies Fail; the neglected role of user innovation during adoption. Research Policy 30.
- Eleni T. (2008). Continued Use of Soil and Water Conservation Practices: a Case study inTulla District, Ethiopia. Master thesis Erosion and Soil-Water Conservation Group and Environmental Policy Group submitted in partial fulfillment of the degree of MSc in Environmental Sciences at Wageningen University, Netherlands.
- FAO (2010). Country Support Tool – for Scaling-Up Sustainable Land Management in SubSaharan Africa. Food and Agriculture Organization of the United Nations, Rome, Italy.

- FAO (2011). The State of the World's Land and Water Resources for Food and Agriculture; Rome, Italy.
- FAO (2015). Food and Agricultural Organization. The State of Food Insecurity: Report 2015 Food and Agricultural Organization, Rome, Italy.
- FAO (2004). The State of Food Insecurity in the World: Monitoring Progress Towards the World Food Summit and Millennium Development Goals. Food and Agricultural Organization of the United Nations, Rome. 265 pp.
- FAO, IFAD and WFP (2015). The State of Food Insecurity in the World: Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome, FAO
- Fikru, A. (2009). Assessment of Adoption Behavior of Soil and Water Conservation Practices in the Koga Watershed, Highlands of Ethiopia. Unpublished Master Thesis, Cornell University, School of Graduate Studies, New York.
- Gebremedhin and Swinton, (2003). Investment in soil conservation in Northern Ethiopia: the role of land tenure security and public programs. *Agricultural Economics* 29: 69–84
- Hoddinott, J., (2002). Food security in practice: Methods for rural development projects. International Food Policy Research Institute. Washington, D.C. <http://www.wikipedia> retrieved on 27/11/2012. Hurni H. Land degradation, famine, and land resource scenarios in Ethiopia. In: Pimentel D, editor. *World Soil Erosion and Conservation*. Cambridge: Cambridge University Press.
- Johansson, L. (2001). Ten Millions Trees Later. Land Use Change in the West Usambara Mountains. GTZ. Eschborn. Germany.
- John, A. (2008). Factor affecting the Adoption of Soil Conservation Measures: A case study in Fijian Cane Farmers. *Journal of Agricultural and Resource Economics* No1.
- Kalusik, et al (2001): Indigenous food security revival strategies at the village level: The gender factor implications. A case study of the Boreda, Ethiopia..
- Katila, P. (2008). Devolution of forestry-related rights. Comparative analysis of six developing countries. Thesis for Award of PhD Degree at University of Helsinki, Finland.
- Maxwell, S., (2003). Household Food Security: Conceptual indicators and measurements; A technical review. UNICEF, New York and IFAD, Rome. Ministry of agriculture and rural development (2010). Sustainable land Management Technologies and Approaches in Ethiopia. Report paper by SLMP and natural resource management sector, Addis Ababa, Ethiopia

- Mesfin Desalegn (2010). Challenges and prospects of land rehabilitation practices: A Case of Angacha Woreda, Kambata Tambaro Zone, Southern Ethiopia. Bwalya, M. (2005). Self-assessing local good practices and scaling up strategies on sustainable agriculture. A case study of Eotulelo Farmers Field School Group, Likamba village, Arumeru district, Tanzania.
- Ministry of agriculture and rural development (2010). Sustainable land Management Technologies and Approaches in Ethiopia. Report paper by SLMP and natural resource management sector, Addis Ababa, Ethiopia.
- MoFED, (2006). Ethiopia: Building on progress: A Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (2005/06-2009/10), Volume II: Policy matrix. Ministry of Finance and Economic Development (MoFED), Addis Ababa, Ethiopia, September 2006.
- Mulugeta D and Karl S (2010). Assessment of integrated soil and water conservation measures on key soil properties in South Gonder, North-Western Highlands of Ethiopia.
- Lal R (2007). Promoting technology adoption in sub-Saharan Africa, South Asia. Crops, Soils, Agronomy News Papers No 52.
- Reyes, T. (2008). Agro-forestry Systems for Sustainable Livelihoods and Improved Land Management in the East Usambara Mountains, Tanzania. Thesis for Award of PhD Degree at University of Helsinki, Finland.
- Reyes, T. (2008). Agro-forestry Systems for Sustainable Livelihoods and Improved Land Management in the East Usambara Mountains, Tanzania. Thesis for Award of PhD Degree at University of Helsinki, Finland.
- Rosegrant, M.W., Cline, S. A., Li, W., Sulser, T. B. and Valmonte-Santos, R. A. (2005). Looking ahead: Long term prospects for Africa's agricultural development and food security. 2020 Discussion Paper 41. International Food Policy Research Institute. Washington.
- Shiferaw, B. (2005). The economics incentives for farmer to adopt intercropping in relation to land size. Environmental Management Journal 54.
- Teklu, E. & Gezahegn, A. (2003). Indigenous Knowledge and Practices for Soil and Water Management in East Wollega, Ethiopia. Conference on International Agricultural Research and Development Held in Gottingen, October 8-10.
- Tesfahun F. (2003). Challenge and prospects of food security in Ethiopia. In: Proceedings of the food security conference. UNNCC, Addis Ababa, Ethiopia, 13–15 August.

- Tesfaye, B. (2003). Understanding Farmers: Explaining soil and water conservation in Kons Walaita and Wello, Ethiopia. PhD. Dissertation Wageningen University. The Netherlands.
- Tolera, M. (2011): Assessing the role of Traditional Land Management Practices in Improving Cropland Productivity: the case of Diga Woreda, Ethiopia.
- Tadele (2014) Effect of Soil and Water Conservation Measures on Selected Soil Physical and Chemical Properties and Barley (*Hordeum spp.*) Yield. Effect of Soil and Water Conservation Measures on Selected Soil Physical and Chemical Properties and Barley (*Hordeum spp.*).
- Tiffen, M. (2003). Transition in Sub-Saharan Africa. Agriculture, Urbanization and Income Growth. *World Development* 31(8)
- Wagayehu B and Lars D (2003). Soil and Water Conservation Decision of Subsistence Farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto
- Woldeamlak B (2006). Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: acceptance and adoption by farmers'. *Land Use Policy* 24(2).
- WFP, (2005). Report on the Cost- Benefit analysis and Impact Evaluation of Soil Conservation and Forestry Measurement. MERET. Addis Ababa. Ethiopia. regional state, Ethiopia.
- URT (2004). The United Republic of Tanzania. Poverty Reduction Strategy. The Third Progress Report 2002/03. Government Printer. Dares Salaam. Tanzania.
- Yanda, P.Z., Majule, E.K. and Mwakage, A. G. (2001). Wetland Utilization, Poverty Alleviation and Environmental Conservation in Semi-arid Area of Tanzania. The case of Singida region, Tanzania. Institute of Resource Assessment, University of Dar es Salaam, Tanzania.

7. APPENDIX - 1

Checklist Questionnaires for individual interview

Title of the research: Soil Conservation Practices and its implication to Food Security

Household Survey Questionnaire to be completed by Household Heads

Dear Respondent,

My name is Abdi Hassen. I am M.Sc. student at Addis Ababa University in the field of Food Security Studies. Currently, I am doing a research on the Soil Conservation practices and its implication to food security among Headed Households in Chencha Woreda, SNNPR. This questionnaire prepared to gather a data aimed to analyze the contribution of Soil conservation practices to food security. In line with this, you have been randomly selected from the inhabitants of these three Kebeles named Tsida, mafona zollo & Amaranabodo.

Thus, the information you give us could help me to understand the existing soil conservation practices and its contribution for food security. The ultimate objective of collecting the information is solely for academic purpose; your response is highly valuable and will be held in utmost confidentiality and will be used only for the analysis of this research. You will not be identified by name in any case. The data collection will be held based on your full consent, only voluntarily based. I would like to inform you that your participation will not incur any monetary return. You are free to refuse to respond to any questions you do not feel comfortable answering or to withdraw from the research all together. This questionnaire will take about 15-20 minutes of your time to respond to the questions.

Thank you in advance for your cooperation.

Household Questionnaires Survey:

Study Region ----- Woreda ----- Kebele -----

Respondents Identification Code ----- Name of Enumerators-----

Date of Interview -----

I. Household characteristics

- 1) What is your age?years
- 2) Sex of household head
 - a) Female b) Male
- 3) Educational level of household head
 - a) No formal education b) Primary school c) Secondary school d) Tertiary
- 4) Marital status of household head
 - a) Not married b) Married c) Divorced/separated d) Widowed
- 5) What is your family size?
 - a) 0 b) 1 c) 2 d) 3 e) >3

II. Farm Characteristics

- 6) Do you own land?
 - a) Yes b) No
- 7) If yes what is your total farm size?
 - a) < 0.25 ha b) 0.5 ha c) 1 ha d) > 1 ha
- 8) If No how do you get land for farm activities
 - a) Borrowing b) hiring c) others (specify) -----
- 9) If you own farm land what is the source of labour? (Possible to choose more than one answer)
 - a) Family b) Casual labour c) Labour in kind d) others (specify) -----
- 10) How many household members are involved in farm activities?
 - a) 1 b) 2 c) 3 d) 4 e) >4

11) Who decides on the use of farm products?

a) Household head b) Family c) others, if any specify -----

III. Soil conservation practices

A. biological and physical soil conservation

12) Do you use biological soil erosion control practice measures in your plots?

Yes=1, No=2

13) If yes, which type do you use in each of your plots? (Possible to choose more than one answer)

1) Crop rotation, 2) Intercropping, 3).Grass strip, 4) .Agroforestry 5).Alley cropping, others specify _____.

14) What are the physical land management practices of soil conservation measures undertaken in your field?

1) Stone bund 2) Soil bund 3) Terrace construction, 4).Contour farming, and 5) Noting

15) Why do you use conservation measures in your plots?

1). to conserve soil, 2).to conserve water, 3).Both 1 and 2 4).others, specify

16) Please would you rank the effectiveness of different Biological and physical land management practices?

1)

2)

3)

4)

17) What results do you expect from your effort on soil conservation practices done on your plots? (Possible to give more than one answer)

1) Reduce soil erosion, 2) Increase soil fertility, 3) Increase crop land productivity, 4) Increase crop production 5) All

18) What other measures are you using to improve soil fertility? (Possible to give more than one answer)?

1) Inorganic fertilizer, 2) Farm yard manure, 3) Fallowing 4) others, specify

19) If your answer in Q. 12 is No, what is your reason of not using biological soil conservation practices?

1) I use fertilizer, 2) I used physical structures to control erosion, 3).my land is fertile, 4) I don't know ittheir role

19.1 In controlling soil erosion (tick)

Types of practices	Very effective	Moderately effective	Less effective	Remark
1. Biological				
-Crop rotation				
- Intercropping				
-Grass strip				
-Green manuring				
-Alley cropping/tree planting				
2. Physical				
-soil bund				
-Contour farming				
- Soil bund				
-bench terrace				

19.2. In improving crop land productivity (tick)

Types of practices	Very effective	Moderately effective	Less effective	Remark
1. Biological				
-Crop rotation				
-Intercropping				
-Grass strip				
-Alley cropping				
2. Physical				
-soil bund				
-Contour farming				
-bench terrace				

V. Household Food Security Situation before and after using soil conservation practices.

A. Food Availability

20) Did you produce enough food for your family consumption from your own land?

1) Yes 2) No

21) If the answer is "no" to Q no. 22 your production is enough for ___ months consumption?

22) In which months do you face serious food shortage?

1) October - December 2) March - June 3) July - September 4) January - April 5) Other months specify-----

23) How do you overcome the food shortage?

1) From relief 2) from market 3) By borrowing from relatives 4) Others. ___ _

B. Household food consumption situation

24) What proportion of your production was consumed by the family before using soil conservation practices?

1) All 2) half of the production 3) one third 4) One fourth

25) What proportion of your production is consumed by the family now?

1) All 2) half of the production 3) One third 4) One fourth

26) What were your usual meals before using soil conservation practices?

1) Cereals 2) Animals and its products 3) Vegetables and fruits 4) All 5) Others (specify) _____ -

27) What are your usual meals at present?

1) Cereals 2) Animal and its products 3) Vegetables and fruits 4) All 5) Others (specify) -----

28). How many times did you eat per day before using soil conservation a day?

1) 3 times 2) 2 times 3) Once

29) How many times do you eat per day in the present time?

1) 3 times 2) 2 times 3) Once

30) For how many months your production was your annual production and income enough for your family consumption?

1) 1-4 months 2) 5-9 months 3) 10-12months 4) > 12months

VI. Institutional Factors

31) Are you getting extension services/advice on soil conservation from the Extension agents/workers?

a) Yes b) No

32) What is the source of information?

a) Extension agents

b) NGOs

c) Village leaders

d) Others (specify)

33) What is your assessment about the level of the extension services that you

Received?

a) Very high b) High c) Moderate d) Low e) Very low

8. Appendix 2

Checklist Questions for Focus Group Discussion

- 1) Are you aware of the soil erosion control practices and technologies?
- 2) Which soil erosion control technologies were introduced in the village?
- 3) What were the most preferred technologies?
- 4) Which approaches were used to introduce soil erosion control technologies?
- 5) What were the reasons for some farmers not implementing some of the technologies?
- 6) What are the benefits of soil erosion control technologies in terms of crop production and income?
- 7) What is the real situation on household food security for those farmers who implemented and not implemented soil erosion control technologies?
- 8) What is the status of extension service delivery in the village?
- 9) What should be done to improve implementation of soil conservation?

9. Appendix 3

Conversion factors

Table: 1. Conversion factors used to estimate Tropical Livestock Unit (TLU)

Type live stock	Factor
Donkey (adult)	0.7
Chicken	0.013
Horse	1.1
Camel	1.25
Heifer	0.75
Weaned calf	0.34
Donkey (young)	0.35
Calf	0.25
Cow and Ox	1

Source: Stock, et al., 1991.

Table: 2. Conversion Factors kilocalorie

Food items	Kcal/KG
Maize	3760
Teff	3589
Wheat	3623
Barley	3700
Sorghum	3592
Faba bean	3514
Chickpea	3732
Lentils	3522

Source: EHNRI, 1968-1997.

Table: 3. Conversion Factor Used to Calculate Adult Equivalent (AE)

Age	Male	Female
<10	0.6	0.6
10 to 13	0.9	0.8
14 to 16	1	0.75
17 to 50	1	0.75
> 50	1	0.75

Source: Stock, et al., 1991.

Table: 4 Conversion factor Used to Estimate Person-days Equivalent (PE)

Age group	Male	Female
< 10	0.00	0.00
10-13	0.20	0.20
14-16	0.50	0.40
17-50	1.00	0.80
>50	0.70	0.50

Source: Here (1986), John (1982), Ruthenberg (1983) and Nair (1985) cited in storck et al (1991)

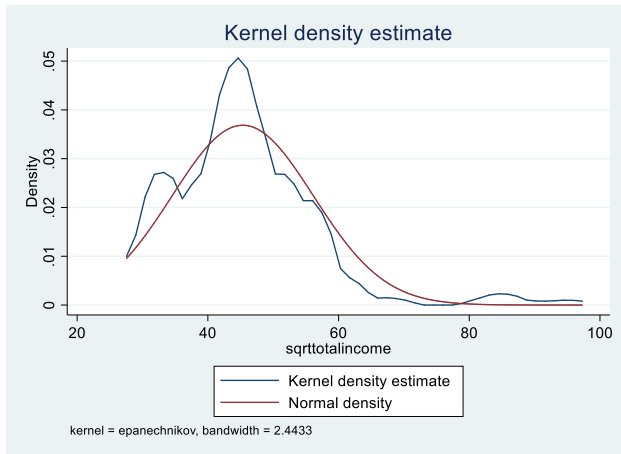


Figure 2 Normality Test for square root of total income

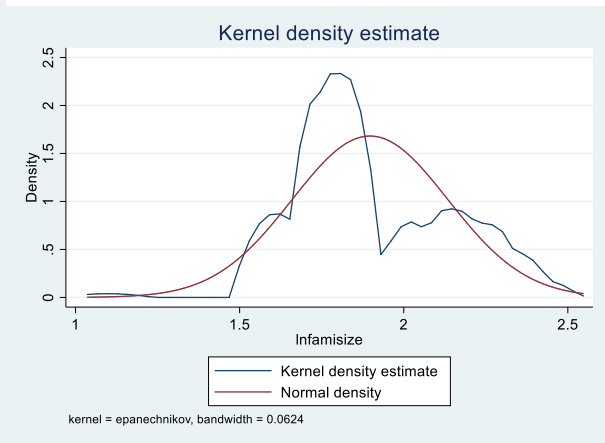


Figure 3 Normality test for ln of family size

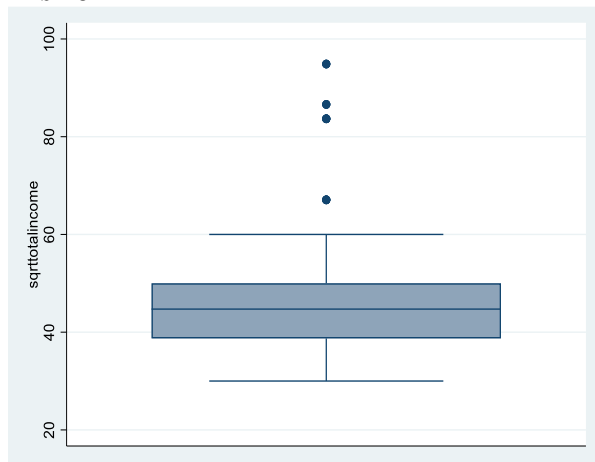
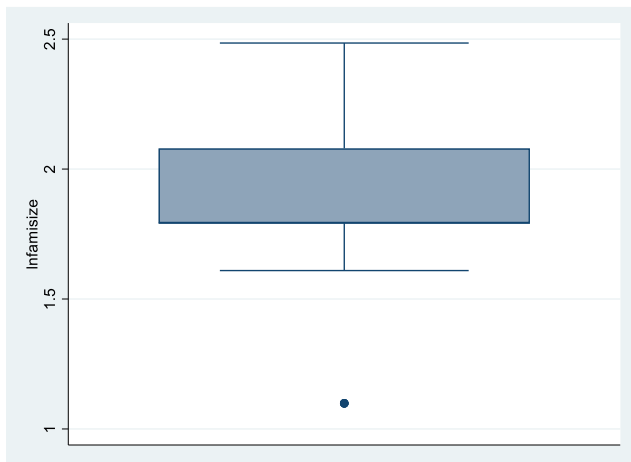


Figure 4 Box plot check for out layers variable total income

Figure 5 Box plot check for out layers (Family size)

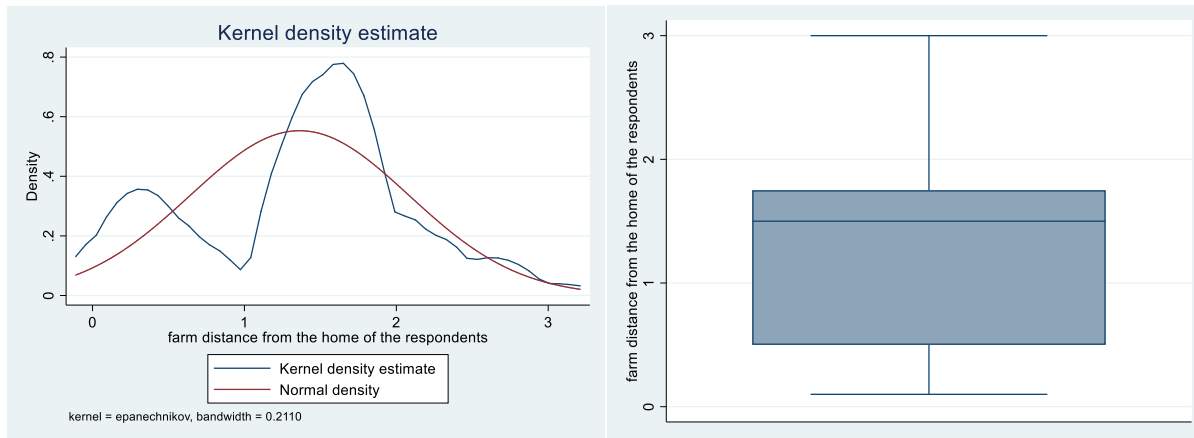


Figure 6 Check for out layers for distance to nearest market

Figure 7 Normality check for distance to the market