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ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDY

CENTER FOR FOOD SECURITY STUDIES

CONTRIBUTION OF SOIL AND WATER CONSERVATION PRACTICES TO HOUSEHOLD FOOD SECURITY IN ENSARO *WOREDA*, AMHARA NATIONAL REGIONAL STATE, ETHIOPIA.

BY

GETENESH ALEMAYEHU TESFAYE

JUNE, 2019

ADDIS ABABA, ETHIOPIA

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This is to certify that the thesis prepared by Getenesh Alemayehu, entitled: Contribution of soil and water conservation practices to household food security in Ensaro *Woreda*, Amhara National Regional state**,**Ethiopia.To Submitted in fulfillment for the requirement for the Degree of Master of science (Food security and development studies)complies with the regulations of the University and meets the accepted standardswith respect to originality and quality.

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ACRONYMS

AAU	Addis Ababa university
AEP	Adult equivalent per person
ATA	Agricultural Transformation Agency
CI	Confidence interval
EHNRI	Ethiopian health and nutrition research institute
EWADO	Ensaro*Woreda* agricultural development office
ETB	Ethiopian Birr
FAD	Food Availability Decline
FED	Food Entitlement Decline
FS	Food security
FFW	Food-for-work
FAO	Food and agricultural organization
FGD	Focus group discussion
Ha	Hectare
HFBM	Household Food Balance Model
GDP	Gross domestic product
HHFS	Household food security
HHH	Household head
SWC	Soil and water conservation
SLM	Sustainable land management
VIF	Variance inflation factor

ABSTRACT

*The aim of this study was to assess contribution of soil and water conservation practices to household food security in Ensaro Woreda, Amhara National Regional State***,** *Ethiopia. Household based cross-sectional research design and mixed methods of data collection were employed in the study. Household survey was conducted on 423 sample households those selected from Stratified random sampled kebele. In addition; household food balance model was used to assess household food security status. For analysis descriptive statistics mainly percent, mean, chi-square and cross tabulation were used. Logistic regression analysis was also done to identify determinant factors for adoption of soil and water conservation measures and food security. Among implemented technologies all farmers used crop rotation as conservation measures. Stone bud, compost and stone-faced soil bund were the most implemented technologies on cultivated land which covered 54.0 %, 23.4 % and 20.6% of the technologies respectively. The research findings revealed that 60.8% of the household were non-adopter and 39.2% was adopter of SWC technologies. And also 73.3% household was food secured but the remaining were food in-secured. The distance to market, perception to technology profitability and SWC training were found significant determinant factors for adoption of SWC technologies. Whereas, family size, total land size, distance to market and adoption of SWC technologies were the factors that affecting household food security status in the study area. As a result, all other factors held were constant, household who adopt SWC technologies on their cultivated land were 14.8 % (0.148*100) higher probability to food secured than SWC technologies non-adopter households. This indicates that there is significant difference between SWC technologies adopters and non-adopters food security status. Therefore, governmental and non-governmental organization emphases should be given for SWC technologies adoption that is suitable for their agro-ecologies and provide training.*

Key- word, Conservation measures, Adoption, Determinant factors, Food security

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Natural resources are useful raw material that came from natural environment. Since humans worldwide obtain more than 99.7% of their food (calories) from the land and less than 0.3% from the oceans and aquatic ecosystems, preserving cropland ,managing soil fertility should be the highest priority to human welfare (Pimentel & Burgess, 2013). Natural resource management refers to the management of natural resource such as water, soil, plant and animals with particular focus on how management affects the quality of life for both present and future generation (Henry, Murphy, & Cowie, 2018).

Agriculture sector in the world is one of the most powerful economic sectors to end extreme poverty and to feed a projected 9.7 billion people by 2050.Whereas, production and demand of food are not balancing in the world. World Bank reports that 2.5 billion people depend on agriculture as their main sources of livelihood. In Ethiopia, agriculture is the main sector of the economy and contributes approximately 42% to the gross domestic product (GDP) and employs over 80% of the population (ATA, 2013).The agricultural sector's fortune directly affects economic development, food security, poverty alleviation and social welfare of the country.

Food security is a dynamic concept, and the level of their analysis over the years has been considered at global, national, regional, state, household (HH) and individual level. Food security refers to the situation "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2010). Many people consider it as a basic human right but approximately about 870 million peoples in the world are to have been undernourished in the period 2010–2012.Hunger remains a major challenge for many countries, particularly in sub-Saharan Africa its levels rose from 777 million people in 2015 to 815 million people in 2016 (FAO *et al.,* 2017). About 10% of Ethiopia's citizens are chronically food insecure and this figure rises to more than 15% during frequent drought years; 2.7 million People require emergency food assistance. Currently nutritional status of under age 5 child in Ethiopian are 38 % stunted,10% wasted and 24 % are under weighted in 2016 (Taddese , 2016).

The main source of food insecurity of Ethiopia are drought and land degradation, population pressure, instability and armed conflict (Mohamed, 2017). Land degradation in the form of soil erosion and nutrient depletion has been a major constraint for the provision of goods and services from rained agricultural. Land degradation associated with soil erosion has been accelerated by exploitative and inappropriate land use and management practices (Shiferaw & Holden, 1998).

On a global scale, the loss of productive land through soil erosion globally estimates about 5-7 million ha/year (Kumar and Ramachandra, 2003) and it is estimated that soil degradation leads to a potential loss of 20 million tonnes of grain per annum in the world (Rickson *et.al.,* 2015). In Africa, 60% of its cropland is affected at various scales (Muchena *et.al.*, 2005). In South Africa approximately 75% of farmers lose more than 21% of their crops yearly due to erosion and 55% said their crops and livestock, as well as their household feeding, suffer due to the problem (Ighodaro, Lategan,& Mupindu, 2016). Similarly, Ethiopia has high level (Hurni, 1998). To address this challenges the government of Ethiopia and non-governmental organization promoting soil and water conservation (SWC) technologies for improving agricultural productivity, HHFS, and rural livelihoods, while simultaneously mitigating environmental degradation (Teshome, de Graaff, & Kassie, 2016).

In Ethiopian, SWC programs starting in the formal way in 1970s after the famine of highly degraded part of Tigray and Wollo area. From that time up to the late 1990s, implementation was top-down, incentive- based (food-for-work) approach that prioritized engineering measures (Shiferaw & Holden, 1998).However, this program was not successful and sustainable due to the implementation approach. Currently different results suggest that watershed management had a positive impact on natural resource conservation, crop-livestock production and productivity, socioeconomic conditions and livelihoods when the involvement of all the stakeholders and farmers is needed during all the phases of conservation management. However, its implementation of the structure are difficult, due to lack of integration bio-physical measure, absence of integrating practices, negative impact of incentives, lack of considering socio-economic profile, low perception and participation of farmer poor conservation design, improper land use less maintenance, week monitoring and evaluation of SWC are major constraints for the implementation of SWC in Ethiopia (Fikirie& Beyene, 2017). Hence, necessary measures must be taken to ensure voluntary participation and to remove the misunderstandings of all the concerned participants (Akkaraboyina & Tareke, 2018).

Ethiopia has great climatic variety, from dry to wet, and also many different altitudes, from lowlands to highlands, the same conservation technologies cannot be applied for everywhere and also the factors affecting the adoption of SWC technologies vary from place to place. However, contribution of SWC practices to household food security in the Ensaro, *Woreda* had never been investigated. Therefore, this study tried to address contribution of SWC technologies to household food security M, determinant factors that affecting for adoption of SWC technologies and evaluating household food security status and copying strategies of farmers. It answered the following research question 1) what type of introduced SWC technologies and approaches implemented in the study area for the last ten years?2)Which factors were contributing to adoption on SWC technologies? 3) were there significant differences in food security status of farmers between SWC adopter and non-adopter farmers? 4) Which type of copying mechanism farmer used by the farmers to recover in case of food insecurity?

1.2 Statement of the problem

Currently Ethiopia has serious problem on the resource of water, air and soil qualities and quantities, and nowadays, the economic implication of land degradation with soil erosion is aggravated in Ethiopia. Rapid population growth, cultivating steep slopes without conservation, overgrazing and clearing of vegetation are the major cause of accelerated soil erosion. All those factors, therefore, affect food security of poor farmer in terms of production and aggravate water scarcity (Tamene & Vlek, 2008).

Ensaro *Woreda*, the study area, is one of the 24 *Woredas* which is found in North Shewa Zone of Amhara National Regional State in Ethiopia. 95.33% of the people live in rural area with their main livelihood of agriculture. In the area mixed agriculture ox-plough system is the major farming system.

The degradation and loss of the soil resulting from erosion, depletion of organic matters and nutrients are much faster than they can be re-placed in Ethiopia (Hurni 1993). Different site-specific research also reported that annual soil loss shows spatial and temporal variations. The significance of soil erosion in Ethiopian highlands ranged from 42 t ha^{-1} y^{-1} (Hurni, 1993) to 179 t ha^{-1} y^{-1} (Shiferaw&Holden, 1999), Amare (2007) estimated soil loss as high as 90 t/ha/yr in Eastern Escarpment of Wello from Steep slope ;Bewket & Teferi (2009), estimated annual soil loss 93Mgha−1 yr−1 for the entire Chemago watershed Blue Nile basin and also North East Wollega rate of soil loss is in the range of 4.5Mgha−1 yr−1 in forestland and 65.9Mgha−1 yr−1 in crop land (Adugna, 2015).

Soil erosion is a cause of losses of soil fertility , reduce crop yield and thereby exacerbate their risk of food security (Fikirie& Beyene, 2017). Lack of capacity to cope and also to replace lost nutrients soil erosion is more serious in developing countries including Ethiopia (Tamene& Vlek, 2008).The loss of soil may have serious impacts on the quantity and quality of soil ecosystem services, with serious economic, social, and political challenges.

The Ethiopian government first recognized the impact of soil erosion after the 1973–1974 famine (Haregeweyn *.et. al*, 2012). This occurred in the highly degraded parts of the country, particularly in Tigray and Wello (Herweg &Ludi, 1999). To address this challenge Ethiopian governments have launched various campaigns on soil, land and water conservation (Haregeweyn *et al*., 2015). As a result, a large number of conservation and afforestation projects were undertaken (Hurni, 1988). A total of 1,252,000 km of terraces and bunds was constructed and 472 million trees were planted(Osman &Sauerborn, 2001). From that time up to the late 1990s, implementation was as part of agricultural package, top-down, approaches focused engineering measures rather than agricultural production (Woldeamlak, 2002).This did not bring a wide dissemination and adoption of the practices by farmers because of farmers constructed SWC practices during the campaign, but they had no interest to implement or expand these without food for work (Shiferaw& Holden, 1998). As a result of these comparative failures, a major rethinking of watershed management approaches was undertaken by national and international agencies (Chimdesa, 2016).

Between 1995 and 2009, soil conservation activities have been undertaken as part of the agricultural extension package of the present government through mass mobilization with a top-down approach and without incentives for the time farmers spent on SWC activities. The approach was to construct conservation measures at individual level but not at watershed level. Emphasis was given to the quantity of measures rather than the quality of measures. SWC is mainly limited to physical measures. Dis-adoption and non-adoption of SWC measures were common phenomena in the period. This indicates that the extension system did not bring about behavioral changes among farmers probably because the focus was on changing the farmland rather than farmers' behavior (Teshome *et al*., 2016).

In 2010 the Ethiopian government launched new a land restoration program that is Sustainable Land Management that aimed to double agricultural productivity through improving the management of natural resources and agricultural lands. The current approach is also mass mobilization, but then at participatory watershed level and it intended to change the attitudes of the farmers and ensure that the SWC structures are sustainable and effective (Mekuriaw et.al, 2018). Since 2010, more than 15 million people have contributed free labor equivalent of US$750 million each year. Physical and biological SWC measures have been introduced in more than 3,000 watersheds managed by local communities(CGIAR, 2015).

Several site-specific studies indicated the positive effects of various SWC structures in reduction of soil loss (Adimassu et al., 2014; Mengistu et al., 2016), improvement of crop yields (Amare B., 2007; Nyssen et al., 2007; Teshome et al.,2013),watershed management increase on farm income by 50% and reduce food security by 56% and the risk of crop failure due to moisture stress and climate shocks by up to 30% (Gebremichael, 2005) and could be part of the country's climate-proofing strategy.

Factors that influencing the adoption and repairing of SWC structures is site-specific in several studies. For instance, the effects of perceived seriousness of erosion, labor availability, and farm land size on construction and repairing of SWC structures were reported (Tadesse & Belay, 2004;Birhanu & Meseret, 2013; Asmame, 2014). Moreover, land tenure and extension services (Asmame, 2014), access to training, membership in local organizations, number of cattle owned, educational level, and off-farm income were indicated as reason for influencing adoption of the SWC structures (Tefera & Sterk, 2010;Birhanu & Meseret, 2013).

Previously there was no empirical research conducted in Ensaro *Woreda* about soil erosion status though there was observable land degradation, which was soil erosion and ensuring SWC sustainability is a problem. To overcome these problems the last many years the governmental and recently non-governmental organizations are supporting sustainable agricultural land management practices as a major part of soil and water conservation practices. Since Ethiopia has great climatic variety, from dry to wet, and also many different altitudes, from lowlands to highlands. Similar type of SWC practices recommendations are inappropriate given the differences in agro- ecologies and other factors (Kato *et. al.,* 2000) because of this site-specific research was vital. The major research gap identified in this area include absence of reliable information on level of soil erosion, food security status ,perception of farmer on erosion and control measures, challenges, effectiveness and contribution of implemented SWC practices to food security improvements of farmers.

1.3 Objective of the Study

1.3.1 Main objective

The overall objective of the study was to assess contribution of soil and water conservation practices to household food security in Ensaro *Woreda*, Amhara National Regional State, Ethiopia.

1.3.2 Specific objectives

1. Identify the introduced SWC technologies and implementation approaches in the last 10 years.
2. Determine the factors that affecting adoption of Soil and water conservation technologies
3. Assess food security status and coping strategies of farm household to the problem of food shortage.
4. Examine the contribution of introduced SWC technologies to food security of farming household.

1.3.3 Research questions

- What type of introduced Soil and water conservation technologies and approaches implemented in the study area for the last ten years?
- Which factors were contributing to adoption of Soil and Water conservation technologies?
- Were there significant differences in food security status of farmers between Soil and Water conservation adopter and non-adopter farmers?
- Which type of copying mechanism did farmers used to recover in case of food insecurity?

1.4. Scope of the study

This study was conducted in Ensaro*Woreda*, Amhara National Regional State, Ethiopia. This study focused on introduced SWC technologies and implementation approaches, determine the factor that influencing adoption of SWC technologies and food security, assess Household food security status (HHFS) and coping mechanism of the farmer and examine its contribution on HHFS.

1.5 Significance of the Study

Conducting research on the complex linkages among adoption of SWC technologies and its contribution to HHFS, perception of farmers about soil erosion problem and measures, food security status and copying mechanism in case of food insecurity would have paramount significance. Conducting research on such contemporary issues is relevant and timely for farmers, policy makers and adds knowledge to the existing literature on the subject area. Furthermore, this study can be used as baseline information about contribution of SWC technologies to HHFS in Ensaro *Woreda.*

1.6 Limitation of the study

Considering the time limit and objectives of the study, this study was limited to the Contribution of SWC technologies to household food security in Ensaro *Woreda*, Amhara National Regional State,Ethiopia.The period of study under consideration was limited to December 2017 to December 2018 production year.

The variables included focused on demographic and socio-economic, perception, institutional and farm characteristic related factors. Moreover, the tools to measure perception of household head loss measurement of perception such as likert scale.

1.7. Ethical Considerations

In the course of this undertaking, an appropriate acknowledgment and citation have been made for any concepts or ideas taken from the literature. Moreover, formal letter of support was written to Ensaro *Woreda* governmental concerned body from center of food security. Explanation was given to farmer about the purpose of the research. Verbal consent from the respondents was requested before conducting the interview. They were informed that confidentiality of individual farmer household information was to be ensured by using unique identifiers. There were no known risks or discomforts associated with the study. Participation in this study was entirely voluntary and that they were free to with draw from the study at any time without any objection.

1.8 Organization of the study

This thesis was structured in five main chapters .The first chapter has introduction of the study that includes the background of the study, statement of the problem, objectives of the study ,research question ,scope of the study, significant of the study ,limitation of the study and ethical consideration. Chapter two presents theoretical perspective and empirical evidences related to SWC technologies and food security with analytical framework. Chapter three discusses the methodological approaches of the study design and research methods such as sample size determination, sampling procedure, data type, source and instruments, data collection procedure, data analysis and description of the variables. Chapter four constitutes of the study to analyzed quantitatively as well as qualitatively the data gathered through different tools concerning the contribution of SWC practices to household food security in Ensaro *Woreda*, Amhara National Regional State, Ethiopia. Chapter five contained conclusions and recommendation of the study

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Review on Concepts and Theories of Food security and SLM

2.1.1 Food security concept and definition

The current broad and comprehensive definition of food security is the result of a long process characterized by different experiences, strategies, views and actors. Food Security as a concept originated in mid-1970s, in the discussions of international food problems at a time of global food crisis. It was coined at FAO's World Food Conference in 1974 (Rome) as 'availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices'. This is the narrowest definition of food security that attempts to explain the concept as the availability of adequate food whether at the global, national and regional level. However, the availability of food at larger scale alone never guarantees food security at household or individual level. Unlike the case in 1970s, the focus of the concept of food security shifted to questions of access to food at household and individual levels in 1980s. In 1983 FAO conceptualized food security as: 'Ensuring that all people at all times have both physical and economic access to the basic food that they need', implying that a balance should be struck between the demand and supply side of the food security equation. AmartyaSen (1981) that argues ensuring access, Sen, explain food insecurity occurs not because there is not enough food, but because people do not have access to enough food.

In the 1986 Poverty and Hunger report of the World Bank, this concept of food security has been further elaborated in terms of: 'access of all people at all times to enough food for an active and healthy life.' It introduced the widely accepted distinction between chronic food insecurity, associated with problems of continuing or structural poverty and low income, and transitory food insecurity, which involved periods of intensified pressure caused by natural disasters, economic collapse or conflict (FAO, 2003).

The World Food Summit (1996) adopted even a more comprehensive definition: 'Food security, at the individual, household, national, regional and global levels is achieved 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’ (FAO, 1996). In this definition the phrase 'safe and nutritious' emphasizes food safety and nutritional composition while 'food preferences' indicates the change of the concept from mere access to access to the food preferred. This implies that people with equal access to food, but different food preferences, could show different levels of food security. This definition is again refined in the State of Food Insecurity Submit (2001) as: ‘…a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary food preferences for an active and healthy life’.

Finally, Food security definition has been identified with the four dimensions of food security: availability, access, utilization and stability. However, food insecurity is defined as a condition in which people lack the basic food intake necessary to provide them with the energy and nutrients required for fully productive lives. In theories two type of food insecurity chronic and transitory can be distinguish (FAO, 2010).

2.1.2 Techniques and methods of food security and insecurity assessment

There are two broad approaches which are used for the analysis of famine. The first approach is the‘Political Economy’ which pointed out a number of environmental and socio-economic attributes which include rapid population growth, war and civil strife, drought, ecological degradation, government mismanagement, unequal access to resources and unequal exchange, and socio-economic and political dislocation (Da Corta 1985 cited in Getachew 1995). This approach argues that one or a combination of these can disrupt food production which may or may not cause production failure that results imprecise explanations of the causation of the process of famine.

The second approach raised in response to this major weakness comprises models of famine as Food Availability Decline (FAD) model and Food Entitlement Decline (FED) model the specific models of famine emerged (Degafa, 2002). The central argument of the former model is that “anything which disrupts food production such as drought or flood and population pressure can cause famine, the logic being that a drought or flood causes crop failure and cattle death, reducing the availability of food in the affected region, and that such a food availability decline for an extended period by definition constitutes a famine" (Devereux, 1988:270). This model also considers the declining per capita food available with Rapid population growth. The model proves this by investigating subsistence farmers' situation that reveals how a failure of production during one growing season would end up with food shortage.

Due to the overemphasized food supply and undermines the demand for available food.However, an alternative method, FED model, for the analysis of famine was pioneered by Amartya Sen (1981). The model suggests that in addition to food availability in the economy or in the Market, access to food plays a crucial role in securing command over food which is, in turn, determined by production, exchange or transfer.

2.1.3. Determinant of Food security

Different factors that affecting food security status of the farmer in Ethiopia**.**Access to agricultural extension services, off farm income, number of oxen owned, total land size and safety net participation are found to be the major determinants of household food insecurity that significantly reduce the level of HHFS. Whereas age dependency ratio, family size, crop disease incidence and fertilizer utilization are uncovered to be significant and positive covariates of household food insecurity in Adwa *Woreda* (Negash& Alemu, 2013). According to Siraje & Bekele (2013) study shows family size, age of household head, dependency ratio, livestock disease incidence were causing food insecurity.Whereas,sex of household head, herd size, income from livestock production and non-farm income were working against food insecurity.

A study conducted by Mesele, Suneetha, & Tigga (2018) , in Norther part of Tigray by using logistic regression model livestock ownership, land holding size, age of head, amount of rain fall, concrete river diversion and deep well irrigation were robust and positively influence food security while family size had a negative effect.

2.1.4. Concepts of Sustainable land management (SLM)

Sustainable land management was emerged as a priority item on the international agenda in the early 1990's and the concept was first introduced by Smyth and Dumanski (1993). Since then many definitions have been proposed to describe aspects of sustainable land management. Hurni (1997) defined SLM as a system of technologies and/or planning that aims to integrate ecological with socio-economic and political principles in the management of land for agriculture and other purposes to achieve intra-and inter-generational equity.

In this connection, Gete *et al*.,(2006) conceptualized SLM in Ethiopian context as the use of renewable land resources, for agricultural and other purposes to meet community needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions through systematic use of indigenous and scientific knowledge/technologies, proper participation of communities on the decision making process (planning, implementation and management), and appropriate policy environments to ensure the successful implementation of the above processes.

In sum, Sustainable land management is a very complex and challenging concept.It encompasses biophysical, socioeconomic and environmental concerns that must be viewed in integrated manner. This includes actions to stop and reverse degradation and mitigate the adverse effects of misuse.

2.1.4.1Severity of soil degradation

Land degradation affected more than 3 billion hectare of the world land (Lal, 2014). As a result more than 3 billion people suffered to this problem (Nkonya, Mirzabaev, & Braun, 2016).This notably challenges influencing agricultural productivity and affected livelihoods of more than 1 billion people (ELD Initiative, UNEP, 2015). African agriculture remains most threatened by land degradation and more than 60% of its cropland is affected at various scales (Muchena *et al*., 2005). In sub-Saharan Africa (SSA), 75% of the population derives their livelihoods from subsistence agriculture Soil degradation induced by water erosion and its consequences are the main concern (Tully *et.al.*, 2015).

Soil degradation is any process that reduces the current and future productivity of soil. Abrol and Oman (2002) defined soil erosion physical removal and transportation of top soil from one place and its deposition to another by various agents such as striking and moving water, blowing winds, strong waves, snow and the forces of gravity.

2.1.4.2 Types and Forms of Soil Erosion

There are two main types of soil erosion, geological soil erosion and human induced soil erosion. According to Hudson (2002) soil erosion which is accelerated by human activities is known as man-made or accelerated erosion. Geological soil erosion is the gradual removal of soil by natural processes acting over a very long time. There are five forms of soil erosion by water. These include; sheet erosion, rill erosion, gully erosion, slip erosion, stream bank erosion and sea shore erosion. Most soil erosion occurs on cultivated land in the form of sheet and rill erosion. However, it also occurs on grassland as gullies and even in forests if they are not properly managed (MOA, 2016).Sheet, rill, and gully erosion are the dominant processes in Ethiopia(Gebremichael, 2005 ; Mushir & Kedru, 2012, Haregeweyn *et al.*, 2015).

2.1.4.3 SWC practices: response to soil degradation and to improve food security

The promotion of land, soil and water conservation measures has been a widespread development in sub-Saharan Africa in a bid to tackle degradation and improve productivity. As a result, several governments have launched various campaigns on soil, land and water conservation measures. 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. Soil erosion is prevented by several agronomic and biological properties. According to Heinrich (2001) soil conservation technologies can be grouped in to two categories; mechanical/physical and biological measures. Unfortunately, many conservation programs designed to address soil and water degradation in the traditional agricultural sector have fallen far short of expectations. Findings have showed that despite a number of potential soil and water management technologies developed, adoption by farmers is still very low (Odi, 2002).

The main reason for the failure to achieve sustainable conservation structures is lack of knowledge and skill on construction practices.Only 34.38% were constructed based on the standardized package set on the national guideline the remaining 41 terraces do not met the minimum standards mentioned in the national standardized package (Molla& Sisheber, 2016).

Physical soil and water conservation are methods which aimed to reduce the velocity of surface runoff and minimize soil erosion by shortening the length and minimizing the gradient of the slope. They also aimed to retain water when it is needed or safely dispose excess runoff. The structures mainly involve different types of bunds, terraces, check-dams, water diversion (cut-off drain, water ways) and harvesting structures (micro basins). Whereas, Biological SWC measures mainly involve tree planting in the form of afforestation or reforestation. Vegetation has a curative and protective value (Chimdesa, 2016).

A study conducted in Iran the farmer used ratoon cropping ,crop rotation ,manure , and conservation tillage as agronomic measures and physical measures such as plastic mulch on soil surface on the borders of rice fields,leveling and terracing of farms, bunds, dikes and dams ,removal of weeds and sediment from canals ,and farm drainage .Plastic mulching can reduce soil erosion, reduce evaporation and retain moisture and suppress weed growth (Ashoori et.al., 2016).

2.1.5 Linkages between soil and water conservation and Food security

According to Braun *et al.* (2003), implementation of SWC practices improves soil fertility and increases crop productivity, which enables farmers to grow more food, which translates into better diets and under market conditions that offer a level playing field, into higher farm incomes. A study conducted benchmark watershed in India, China, Thailand and Vietnam watershed management is seen as an entry point for improving livelihoods a achieving food security and has resulted in increasing agricultural productivity by 2 to 3 folds, doubling the family incomes, and reducing runoff up to 66% and soil loss by $2/3^{rd}$ (Wani *et.al* , 2010). On the other hand , study conducted by Meliyo, Masuki, & Mowo, (2007) in Tanzania SWC measures contributing to livelihood of the farmer who conserved their land had 3 to 5 folds yield increase and food security increased from 3 to 9 months $y\ r^{-1}$.

2.2 Review of empirical findings of studies on food security and SWC nexus in Ethiopia

2.2.1 Food security situation in Ethiopia

Ensuring food security remains a challenge in a world with a growing and more demanding. In 2017, the number of undernourished people is estimated to have increased to 821 million around one out of every nine people in the world; more than 23.2 % of the population may have suffered from chronic food deprivation in sub-Saharan Africa(FAO *et al.,* 2017). More than 41 % of the Ethiopian population lives below the poverty line and above 31 million people are undernourished. Similarly, the number of food insecure people in the country recently increasing; which was estimated to 2.9 million in 2014 and 4.5 million in August, 2015 and more than doubled to 10.2 million at the end of the same year. Consequently, 27 million Ethiopian became food insecure as a result of 2015 El Niño drought and 18.1 million dependents on relief food assistance in 2016 out of this 7.9 million supported by Ethiopian government Productive safety net program (SNP).

Different site-specific research indicated high prevalence of food insecurity in rural farmers. According to Negash and Alemu, (2013) study results in Tigray region Adawa district 63.33 % of the HH has been food insecure,65.8% of household food insecure in Chifra*Woreda* afar region (Siraje& Bekele, 2013). Similarly to this study a study conducted in Bilate watershed southern part of Ethiopia by using Household Core Food Security Module 63% of the HH are food insecure (Genene & Wegaye ,2010) , 42.9% of the HH are food insecure in rain fed area in Ethiopia and Ambara discrete(Wani *et al.*, 2010; Thirumarpan, 2014).

A number of factors that affecting food security situation in the world those factors are vary from one place to place. Drought and climate change, shortage of farm land, lack of functional multi-party democratic systems, land reform policy, lack of appropriate policies and institutions, lack of rural infrastructures(schools, roads, markets and health), population growth and lack of education are the major causes of food insecurity in rural Ethiopia (Sewnet, 2015). Similarly to this Wassie & Alemu (2016)confirmed ,drought, poor health, erratic rainfall, backward agriculture, poor infrastructure facility, natural disaster, land degradation, population pressure and low level of technology were the major factor. Whereas, drought and land degradation, population pressure, instability and armed conflict are major sources of food insecurity problems in Ethiopia(Mohamed, 2017).

2.2.2 Coping strategies practiced in Ethiopia

Maxwell (1996) classified household responses to food insecurity into two ways coping strategies and adaptive strategies. Adaptive strategies involve a permanent change in the mix of ways in which food is required; irrespective of the year in question and it refer to long term adjustment. Whereas, coping strategy defined as a mechanism by which HH or community members meet their relief and recovery needs and adjust to future disaster related risks by themselves without outside support (Tesfaye, 2005).

According to Maxwell *et al*.,(2002), there are four types of coping strategies that food insecure households typically use: Changing the diet, increasing food supplies through non-sustainable means,decreasing the number of individuals being fed by the HH and Rationing available foods by reducing meal size or frequency. Siraje &Bekele, (2013) pastoralist HH in afar region frequently use sale of sheep and goats (shoats), reducing number and size of meals; seasonal migration (some of the family members), receiving food aid and borrowing cash or food from neighbors or relatives as coping strategies. Similarly to this Ethiopian rural HH practiced minimizing number and quantity of meals in a day, diversifying livelihood income sources, migration, and wage labor (Sewnet, 2015).

On the other hand , a study conducted by Negash and Alemu, (2013), selling household asset, leaving the entire days without eating and sending household members for beg. Almost, in all nine regional administrations of Ethiopia rural HH use the same coping strategies such as people use sale of livestock, agricultural employment, and migration to other areas, requesting grain loans, sales of wood or charcoal, small scale trading and limiting size and frequency of meal as major coping mechanisms to cope with food insecurity and harsh life (Mohamed, 2017).

2.2.3. Soil erosion level, cause and its impact in Ethiopia

Studies made in different parts of Ethiopia also reported that high level of annual soil loss show spatial and temporal variations. According to Gebremichael (2005) estimated 57 t in North Tigray ha^{-1} y^{-1}, 93 t ha^{-1} y^{-1}in the chemoga watershed Ethiopia (Bewket & Teferi, 2009), Debre

Mewi watershed erosion rate was 8 to 32 t ha^{-1} (Tana, 2010), Mushir and Kedru (2012) estimated annual soil loss recorded in Ethiopia 114.59 tons/ha/year on the steep slopes, Haile and Fetene (2011) estimated that about 97.04% of Kilie catchment East Showa, have 0–10$Mgha^{-1}$ yr^{-1} the soil loss rate by water ranges from 16 to over 300$Mgha^{-1}$ yr^{-1} in Ethiopia (Tesfaye *et al.,* 2014.),erosion rate and also Spatio-temporal variations that range from 4.5 $Mgha^{-1}$ yr^{-1} in forest to 65.9 $Mgha^{-1}$ yr^{-1} in cropland (Adugna, 2015).

Soil erosion loss affected the agriculture sectors in the world .FAO estimates that over the past 40 years, erosion has removed nearly one-third of the world's arable land from production (Fischer et al., 2011),South Africa about 75% of farmers they lose more than 21% of their crops yearly due to erosion and 55% said their crops and livestock, as well as their household feeding (Ighodaro, Lategan, & Mupindu, 2016). Similarly ,crop fields are affected by annual soil losses ranging from 24 to 160$Mgha^{-1}$ yr^{-1} in western Ethiopia (Tefera& Sterk, 2010).The annual rate of soil loss in the country is higher than the annual rate of soil formation rate.

2.2.4. Historical perspective of SWC Practices in Ethiopia

The importance of soil conservation was largely neglected in Ethiopia prior to 1974. The problem attracted the attention of policy makers and international donors only after the disastrous drought and famine particularly in Tigray and Wollo. An effort to halt the problem of soil erosion started after the Ethiopian government initiated massive soil conservation programs following the 1975 land reform. A large number of conservation and afforestation projects were undertaken by food-for-work (FFW) programs (Hurni1988). This massive campaign in soil conservation under FFW did not bring a wide dissemination and adoption of the practices by farmers. This is because farmers constructed SWC practices during the campaign, but they had no interest to implement or expand these without food for work. Most of the conservation measures were removed after the government changed in 1991 (Shiferaw &Holden 1998).

Between 1995 and 2009, soil conservation activities have been undertaken as part of the agricultural extension package of the present government through mass mobilization with a top-down approach and without incentives for the time farmers spent on SWC activities. The approach was to construct conservation measures at individual level but not at watershed level. Emphasis was given to the quantity of measures rather than the quality of measures. SWC is mainly limited to physical measures. Dis-adoption and non-adoption of SWC measures were common phenomena in this period. This indicates that the extension system did not bring about behavioral changes among farmers probably because the focus was on changing the farmland rather than farmers' behavior. Since 2010, the government of Ethiopia has embarked again on a massive SWC campaign. The current approach is also mass mobilization, but then at watershed level. And there is an attempt to make such SWC program more participatory (Teshome,*et al.*, 2016).

The traditional and indigenous methods were applied and practiced in different part Ethiopia. According to Amare.B (2007) study fourteen types of indigenous and about eleven externally introduced and adapted SWC technologies that are currently in use in Eastern Escarpment of Wollo such as stone, soil, and stone faced soil bund and agro ecology, Fanyajuu, tree planting, area closure, micro basin, trench, hill side terracing, check dam and cut-off-drain.Mekuriaw et al., (2018), about 87% of Ethiopian highlands were using physical SWC structures to keep the soil on their cultivated land and to improve crop yields. On the other hand, fallowing, distribution of manure and soil (stone) bunds are the most important conservation structures widely used in southern Ethiopia (Mushir & Kedru, 2012). In Guba Lafto the most common physical SWC include stone bund, stone faced soil bund, check dam, and fanya-juu terrace. Agronomic conservation measures contour farming, mixed cropping, and crop rotation and afforestation, agro forestry, area closure and grass strip are biological measures (Asnake & Elias, 2017).

2.2.5. Farmers perception on soil erosion and control measures

Farmers' willingness to use SWC practices is largely determined by their knowledge of the problem of soil erosion. Farmer's awareness about the problem and causes of soil erosion as well as its consequences will help to motivate farmers to use soil conservation practices(Amsalu & Graaff, 2006). Different site specific research confirmed the majority of the farmer aware about soil erosion and its impact on productivity (Teshome *et al*., 2016; Tadesse & Belay, 2004 ;Jaleta M. *et al.*, 2016 ; Tefera & Sterk, 2010; Adugna, 2015) but they did not invest much in SWC measures because they do not perceive a significant advantage to their use and lack of short-term economic benefit(Mekuriaw *et al*,2018). Additionally to this, farmers perception about the technologies be able to shelter for pests, difficult to tillage , and rats, need much labor, need incentives to implement, difficult to implement and reduce farm size are the factors affecting the adoption of SWC technologies (Mushir & Kedru, 2012).

High percentage of farmers awareness and using SWC structure does not mean that so much land is protected (Mekuriaw *et al.,* 2018) there is a large difference in the intensity of SWC adoption among adopter categories (Teshome, *et al.*, 2016). Therefore, clear understanding of the benefits of SWC structures by farmers, active involvement and technical support from the government, and genuine participation of farmers in SWC practices are critical issues to implement effective measures (Mekuriaw *et al*., 2018).

2.2.6. Contribution of SWC to food security in Ethiopia

In Ethiopia, different study confirmed the positive impact of SWC measures. According to Gebremichael (2005), it contributed on farm income and food security by 50% and 56% respectively. Also, reduce the risk of crop failure due to moisture stress and climate shocks has reduced by up to 30% in Northern Tigray.

According to Melaku *et al*., (2018), prediction of SWC structure impacts on runoff and erosion processes by using SWAT model in the northern Ethiopian highlands, it reduced soil loss by 25–38% in the treated Gumara- Maksegnit watersheds.Study conducted in Northern Ethiopian reported crop yields increased by 7% compared to the situation without stone bunds and also yield increased from 632 to 683 kg ha^{-1} for cereals, from 501 to 556 kg ha^{-1} (11%) for Eragrostistef and from 335 to 351 kg $ha^{-}1$ for Cicerarietinum(Vancampenhout, Nyssen, & Gebremichael, 2006). SWC has a significant role in maintaining and/or restoring soil fertility, maintaining agricultural production, restoring vegetation cover, and mitigating anthropogenic land degradation (Shiene, 2012). The study conducted by Haregeweyn *et al*.,(2015), estimate a mean seasonal runoff reduction of 40%, with large spatial variability, ranging from 4%in AnditTid (Northwest Ethiopia) to 62% in Gununo (South Ethiopia). Similarly, soil loss was reduced by an average of 65% because SWC technologies.

The establishment of slow forming terraces therefore is of vital importance in fighting desertification and establishing sustainable agriculture in the Ethiopian highlands (Vancampenhout et al., 2006).Additionally, 80 % farmers benefited from natural resources by grazing their livestock and harvesting firewood and grasses (Eshete *et al*., 2015).

2.3. Analytical framework

This research would follow the analytical framework depicted in (Figure 1)which explains the relationship among variables that affect adoption of SWC which in turn affects food security. They include demographic and socio-economic factors, perception, farm characteristic and institutional factors affecting adoption of SWC. The outcome of the study would be providing weather adoption of SWC technologies is contributing on household food security status of the farmer or not. The linkage and interaction of determinants of adoption of SWC between household food security statuses are explained as follows.

Demographic and Socio-economic factors

Age the effect of age of the farmer on SWC practices may be either negative or positive .Older age often associated with long years of farming experience could positively influence conservation decision (Amsalu& Graaff, 2006 ; Nkegbe, 2011; Mango, *et al* ., 2017). In contrast, younger farmers with longer planning perspective are likely to invest more in conservation (Asfaw& Neka, 2017; Mountain & Park, 2018).

Sex the effect of sex may be either negative or positive SWC practice.the male headed the HH have a higher chance to involve in SWC practice than female headed since constructing and maintain SWC practice demand much labour and energy (Asfaw& Neka,2017). However, Mountain & Park, (2018) stated the negative influence of sex on SWC practice. On the other hand , sex of the household did not significant effect on SWC technologies (Mango *et al*., 2017; Mekuriaw *et.al* ,2018).

Family size the small sized HH family is less likely to involve in retaining of SWC technologies practices than larger sized HH family. The larger sized family could provide the required labor for implementing and maintaining conservation practices (Nkegbe, 2011) . However, Mango *et al.*, (2017) and Mekuriaw.*et.al* (2018) reported, family size did not significant effect for SWC practice.

Education better education level of HHH having strong and positive relationship with farmers' adoption of SWC conservation practices. Better exposure to education increases farmers' better understanding of the benefits and constraints of soil conservation (Mekonnen & Abiy, 2014; Asfaw & Neka, 2017; Mango *et al*., 2017; Meseret & Amsalu, 2017).On the other hand ,education did not had significant impact on SWC technologies (Mekuriaw.*et.al* 2018).

Participation of off-farm Participation in off-farm work could keep the labor force needed for Conservation away from the farm because of this negatively relationship between SWC practices. (Tenge *et al.* 2004; Asfaw & Neka, 2017; Mountain & Park, 2018).

Livestock size on adoption decision was significantly negative. This indicates that large livestock size discourages conservation investments, perhaps due to the tendency of HH to focus more on livestock than on crop production (Amsalu& Graaff, 2006; Nkegbe, 2011).

Labour availability The amount of farm labor has an influence on SWC measures. This imply that HH who have more persons full time involved in agriculture are more likely to invest in and maintain SWC measures (Teshome, Graaff, & Kassie, 2016).

Household head perception factors

Perception of Farmers about soil erosion as a problem and understand long term technologies profitability are one of the factors to adoption or non-adoptions of SWC(Amsalu & Graaff, 2006).
Perception erosion Farmers who perceived the problem better are expected to invest more in conservation measures (Teshome, Graaff, & Kassie, 2016). Incontrast, Amsalu & Graaff, (2006) reported non-significant association SWC technologies.

SWC technologies Profitability Farmers would likely adopt conservation practices if they perceived the long-term technologies profitable (Amsalu & Graaff, 2006).

Farm characteristic factors

Farm size the effect of farm size on impact of SWC can be positive or negative**.** Farmers who hold large farms are more likely to invest in conservation (Amsalu & Graaff, 2006; Teshome, Graaff, & Kassie, 2016).On the other hand , more land may reduce the need to conserve land (Mountain& Park 2018).

Land tenure the effect of land tenure security had positively affecting on farmers' conservation decisions (Tefera & Sterk, 2010). However, land tenure did not have significant effect on SWC practices (Amsalu & Graaff, 2006; Mekuriaw *et al.*, 2018).

Farm location distance of farmland from homestead is negatively correlated with the adoption of introduced SWC technologies since it is difficult to implement and maintain regularly (Nkegbe, 2011; Gebremedhin & Swinton , 2003 ; Asfaw & Neka, 2017).

Institutional factors

Agricultural extension service and training on SWC measures are the basic tools for smallholder farmers to get awareness about SWC ,the mechanism how to implement it and improve production methods because of this both of them were positively affecting SWC measures (Nkegbe, 2011; Asfaw & Neka, 2017; Mango et al., 2017; Mountain & Park, 2018).

Market lack of market access was negatively affecting implementation of SWC Practice due to increased production costs and unsatisfactory profit margins farmers get (Gebremedhin & Swinton, 2003; Nkegbe, 2011).

Access to credit and ability to relax capital constraints positively affect SWC technology adoption (Boureim, *et. al*, 2018).

Adoption of SWC confirmed in different study the positively impact on household food security status of the farmer as improving soil fertility ,agricultural productivity ,income and significantly contributing HHFS (Gebremichael ,2005;Vancampenhout *et al.,* 2006; Wani *et al.,* 2010;Shiene, 2012).

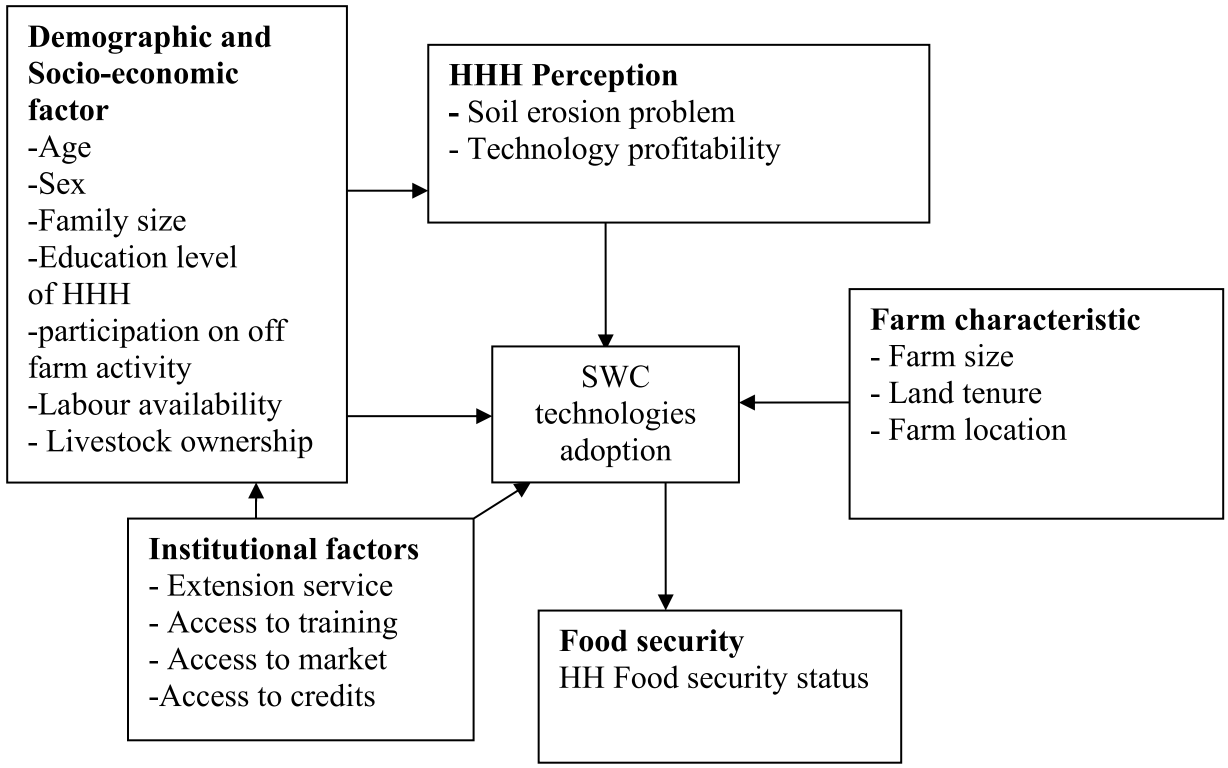

Fig .1 Analytical frame works Source: Derived from related literature review

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Description of the study area

Ensaro *Woreda* is one of the 24 *Woredas* which is found in North Showa Zone of Amhara National Regional state in Ethiopia. Geographically the *Woreda* is located between 9º 35ˈ- 9º 55ˈ latitude and 38º 40' - 39 º 10ˈ longitudes. The *Woreda* has one urban *kebele* and 12 rural *kebele's*. The capital of the *Woreda* is Lemmi town which is located at 130km away from Addis Ababa and 85 km from Debir Birehan. According to Central Statistical Agency (CSA)of Ethiopia projection from 2014 to 2017, the *Woreda* had a total population of 66,201 of whom 33,816 were male and 32,385 females,4678individual were urban while 61,523 were rural.

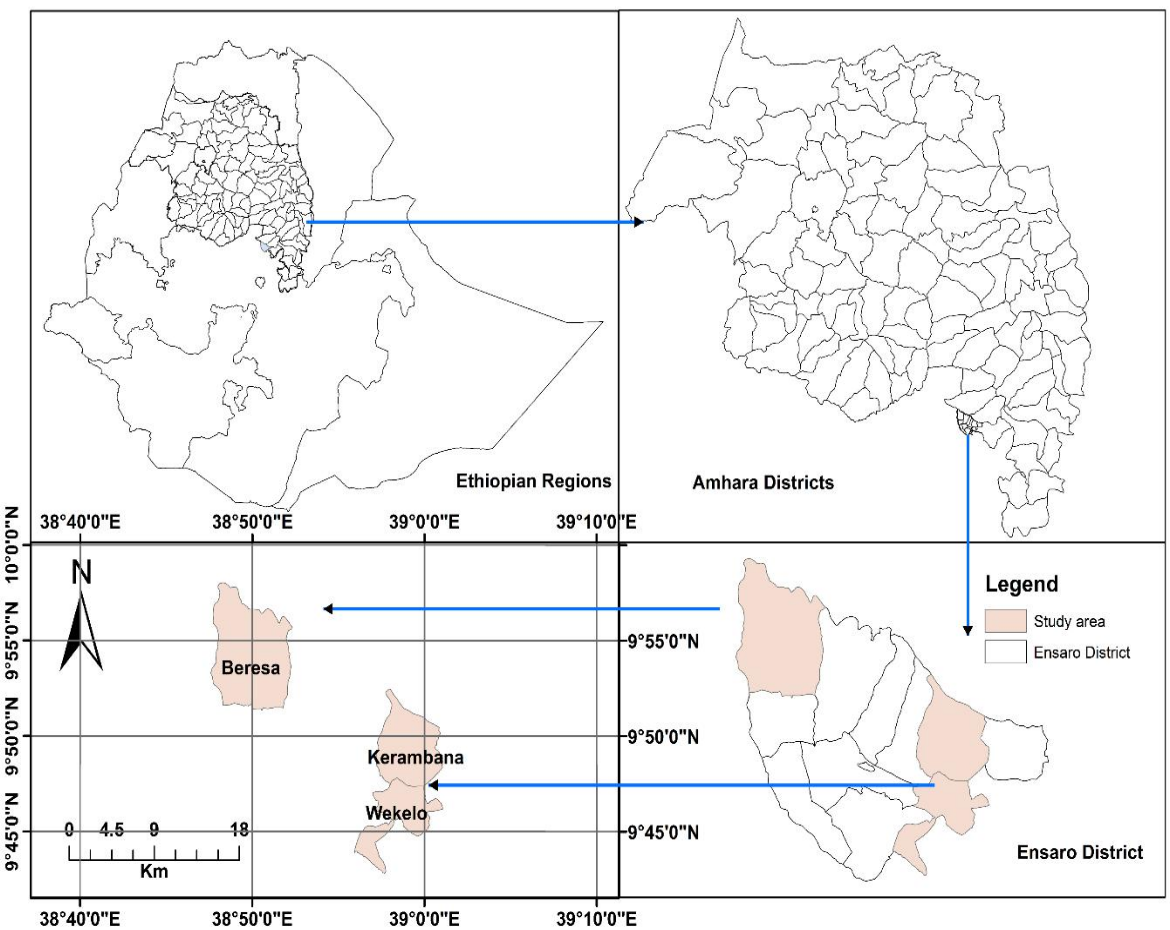

Fig .2 Location of Ensaro *Woreda* (Source CSA,2018)

Land use category

According to EWADO (2018) land use system of Ensaro*Woreda*. Out of the estimated total land area of 44,217.6 hectare; 21,465 hectare (48.5%) is arable land, 3911 hectare (8.8%) is used for grazing, 6,707 hectare (15.2%) is covered with shrubs and afforested plants , 186.1 hectare (0.4%) covered with water, 11,948.56 hectare (27.02%) is allocated for residential and infrastructure development.

Climate, Soil type and vegetation coverage

According to EWADO (2018), Dega (21%), Weyinadega (46%) and kola (33%)zone are the main agro-ecology. The average annual rainfall amount varies between 900 to 1500 mm and average temperature is in between 18°c-30°c.And also, clay loam, clay to clay loam and clay to silty clay loam soil type were dominated soil type in the study area it covers 40.9%, 33.6% and 25.5% respectively. The forest land is covered the third highest percentage of the area which covers 15.2% of the *Wored*aas total area. This forest and shrubs are used as source of fire wood, forage (fodder) especially for goat, sheep and in the nearest time the people used tree planting of cattle fodder trees like (*Saspania, Trilusern etc.)*

Economic activity

Most of the people in the area are engaged in mixed agriculture. Crop cultivation and livestock production are practiced. Crop production is entirely rainfed, except in very specific and small areas where vegetables are cultivated based on traditional and small-scale irrigation. There are two rainy seasons, *kiremt* and *belg*, and they are used for the cultivation of long cycle crops system and land preparation is carried out using mainly ox-plowing but tilling by hand occurs in the hilly areas on steeply sloping lands. Teff, wheat, barley, maize, sorghum, green paper, bean, gomenzer, pea, nug, lentils, shimbra, guaya, telba, suff, and abish were the dominant crops of the study area .The type of domestic animals found in the *Woreda* include: cattle , pack animals, sheep ,goats and poultry(EWADO,2018).

Infrastructures

Regarding distribution of towns, light, schools, health services, road and market.Ensaro *Woreda* has 1 town only at for 13 *kebeles*. According to *Woreda* education office it has one secondary school and 13 primary school. Out of 12 rural *kebele* only *4 kebeles* had access to light.According to *Woreda* health office, also indicates that the *Woreda* has 13 health centers and 4 clinics distributed. In addition, the area has 4 veterinary posts with very limited service to *Woreda's* population. Amhara credit and saving institution is the only institutions who serve credit for the communities and there is also one main road that crosses the *Woreda* to the neighboring *Woreda* and there are some roads to link *kebeles* and also only one market in the *Woreda*for buy agricultural inputs and sell their product as a result the farmers suffering lack of road and transport access the majority of farming house enforced to travel on foot for long hours.

3.2 Study Design

The study was cross-sectional study design. Cross-sectional surveys are used to gather information on population at a single point in time. And also, mixed qualitative and quantitative approaches were used to answer the research questions outlined and address the four specific objectives set.

3.3 Research methods

3.3.1 Sample Size Determination

Usually the sample size was determined considering the heterogeneity of the community, complexity and coverage of the questionnaire, the time available and the funds that are feasible. The sample size was determined using statistical formula for a population size (N) that was greater than or equal to 10,000 recommended by Kothari (2004), which was calculated using the following empirical formula:

$$n = \frac{(Z)^2)P(1 - P)}{d^2}$$

$$n = \frac{(1.96)^2)(0.5)(1 - 0.5)}{0.05^2} = 384$$

Z = standard normal distribution corresponding to significance level at d= 0.05 or confidence interval (CI), 95% = 1.96, by using single population proportion formula, taking prevalence p = (50%), marginal of error=5% and 95% CI, a none response rate of 10% the sample size was calculated as to be 423.

Since the number of populations living at different agro-ecology zone were not the same, proportional number of representative's samples for each agro-ecology zones were considered and obtained by applying the following formula.

$n_1 = nN_1/N$, Where n= number of HH

N= Total HH in the *Woreda* that was 12056

N_1= The summation of HH in each agro-ecology zone

Table 1 Distribution of sample by agro-ecology and study *kebele*

Agro-ecology zone	Population size (N1)	Selected *Kebele*	Allocation sample size
Dega	3537	Wekelo	124
Weyinadega	4761	Karamba	167
Kolla	3758	Beressa	132
Total	12056	3 kebele	423

3.3.2. Sampling Procedure

The representative sample was selected from the total population under the study, from the total household farmer's and *kebele* administration of Ensaro *Woreda*. Regarding procedure of sampling, stratified randomly sampling design was employed. The *kebeles* was stratified in to three agro-ecology zone and randomly selected three *kebeles* namely karamba, Wekelo and Beressa. The *kebles* were selected randomly depending on the three agro-ecology zones, proportionally allocating from each zone. Finally, HHH was selected systematic through random sampling.

3.3.3 Data type, source and instrument

Types of data collected was on demographic and socio-economic and farm characteristics of farming household head, institutional factors that affect adoption of SWC practices, perception and knowledge of farming HHH on soil erosion as a problem and profitability of SWC technologies, types and magnitude of SWC technologies implemented, household's food security status and their copying mechanism to address food insecurity. Sources of the data were both primary and secondary data. Instruments that were used to collect the primary data include questionnaire survey, focus group discussion (FGD), key informant interview and personalfield observation. The detail of collection procedure is depicted here under.

3.3.3.1 Primary data

The main instrument used for data collection was a structured questionnaire, Focused Group Discussion (FGD), key informant interview (KI) and personal field observation to address specific objectives of the study.

Household questionnaire

Household questionnaires were open and close-ended questions that were pre-tested and also developed in English and translated in to Amharic which is the official working language of the *Woreda*. Interviews were conducted with household heads about socio-economic characteristics, perceptions on soil erosion and conservation measures, implemented technologies on their farm land, farm characteristics, institutional factor, food security status and coping mechanism in the case of food shortage.

Personal field observations

From each *kebeles* few selected representative fields were visited to assess the existing technologies and different management practices. Field observations were done in order to verify and supplement the information collected during household surveys. During observation, field notes and photographs were taken. While conducting observation, informal discussions with farmers working on their plots were made to get further clarification on the issue of interest.

Focused Group Discussion (FDG)

Total of three focus group discussions were conducted. The participant was purposely selected with groups of six to eight male and female headed farmers of various ages and adoption status from selected *kebele* and were used to obtain community views on historical and current trend of SWC practice, implementation approached, perception of farmers about soil erosion as problem and technology profitability, food security situation of the farming household and also copying mechanism in case of food insecurity. The discussions were guided with checklists of discussion topics. This approach was very important to cross-validating information and filter out controversial and contested issues through debate and dialogue on the topic of interest. This kind of discussion also helped handle exaggerated views that might be given by some individuals (Woldeamlak, 2003).

Key informant interview

Nine key -informants were purposely selected from *Woreda* agricultural office natural resource development experts (1), agricultural extension and crop productivity expert (1),risk management and preparedness experts(1) and also information were drawn from study *kebele* agricultural extension officers(3) and community representatives(elders) (3) related to SWC practices and food security issues.

3.3.3.2. Secondary data

Secondary data source was also used as source of information. In this regard, additional information was obtained from the governmental offices documents such as annual reports and household head list at *Woreda* and *kebele* level.

3.3.4 Data Collection Procedures and Data quality

All participants (n=423) were provided with oral informed consent. Primary and secondary data was collected. The data was collected by trained data collectors. One day of training on how to approach and fill out the questionnaire before they visited each household and interviewed the respondents in person and theoretical training about subject area was given for three data collectors. And also to assure the quality of data the questionnaire were pre-tested, coding and data cleaning (checked frequencies and cross-tab for each item) were used.

3.3.5. Data Analysis Techniques

Data was coded and entered in to SPSS version 23 and export to STATA version 14.2 for analysis. Descriptive statistical summary measures (i.e. means, standard deviation, frequencies, percentages and cross tabulation) were used to understand the collected data and also chi-square test for determine the association between HHFS and adoption on SWC technologies. Econometric model binary logistic regression was used to predict the relationship between SWC adoption and independent variables tested at 5% significant level.Binary logistic regression model were used to identify the major explanatory variables for food security, which adoption of SWC was one variable.

For this analysis post-estimation test were done after logistic regression. In order to test the existence of multi-collinearity, both the continues and discrete explanatory variables were checked using variance inflation factor (VIF).This statistical analysis indicates that there is no strong association among the variables (Annex 2 and 4). And also, hetroscedasticity and goodness -of- fit test was calculated to auto correlation and appropriateness of data with model. The information gathered from focus group discussion, key-informant interview, and personal field observations were analyzed qualitatively.

3.3.5.1 Assessment of household food security status

Farmers' household food security status can be assessed using different models. For this study Household Food Balance Model (HFBM) is applied. This equation was originally adapted by Degefa (1996), from FAO regional food balance model and thenceforth used by different researchers in Ethiopia which was employed to compute the net quantity of per capita food.The net available food per household per annum, as reported from household recall, is converted into dietary energy equivalent using Ethiopian health and nutrition research institute EHNRI/FAO (1998)'s Food Composition table for use in case of Ethiopia. Then, annual kcal availability per household was converted to daily kcal per adult equivalent. Medically recommended level of calorie per adult equivalent (2200kcal/day/person for Ethiopia) is used as a cut-off point for food insecure and food secure households set by Ethiopian government. The model was given by the following equation.

NGA = (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

3.3.5.2Econometric model to assess determinants of SWC adoption

In order to assess contribution of SWC to food security, it is felt necessary first to assess the adoption level of SWC in the study area. Adoption of SWC technologies by a farmer was assessed using criteria indicated in Table 2.

Table 2: SWC technologies adoption criteria.

SWC Technology	Indicator
Adopter	• Implement at least 50% of introduced technologies suitable to their farming area • Performed maintenance on SWC measures
Non-adopter	• Not performed SWC at all and/or cannot performed maintenance and implement less than 50% of the introduced technologies

Source;Authors, 2019

Furthermore, determinants of adoption of SWC practices were analyzed by binary logistic regression model used socio- economic, HHH perception, farm characteristic and institutional factors as explanatory variable for adoption of SWC technologies and food security. Relationship between farmers HHFS status and adoption of SWC technologies was analyzed by chi-square test and also used adoption of SWC technologies as an explanatory variable for HHFS.

For this study, a model that reflects the determinants of adoption of SWC measures is used. Different literature on soil and water conservation investments was assessed to select appropriate model. Logit and probit models are popular statistical techniques in which the probability of a dichotomous outcome (such as adopter or non-adopter) is related to a set of explanatory variables that are hypothesized to influence the outcome (Neupane et al., 2002). However, Pindyck and Rubinfeld (1981) acknowledged logistic probability function as computationally easier to use than the other types. That is why logistic regression model was used for this study.

$$Pi = F(\alpha + \beta Xi) = 1 / 1 + e\text{-}(\alpha + \beta Xi)$$

Where: Subscript i denotes the i^{th} observation in the sample; Pi is the probability that an individual will make a certain choice given X_i; e is the base of natural logarithms and approximately equal to 2.718; Xi is a vector of exogenous; variables α and β are parameters of the model, β_1, β_2……, βk are the coefficients associated with each explanatory variables X_1, X_2, …, X_n. The above function can be rewritten as:

$$\ln [P /(1- P)]= \beta 0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k$$

Where: P/ (1-P) is the odds (likelihoods); β0 is the intercept; β_1, β_2 … and β_k are coefficients of the associated independent variables of X1, X2…and Xk.The effect of the independent variables (e.g., β1) is interpreted as the odds (likelihoods) of the outcome increases or decreases by a factor of $e^{\beta 1}$. The quantity $e^{\beta 1}$is called the odds ratio. The odds ratio is a measure of association between the independent and the dependent variables. While the estimated coefficients from logistic regression are not easily interpretable, odds ratios might provide a better summary. Marginal effects are an alternative metric that can be used to describe the impact of independent variable on dependent variable. Marginal effects can be described as the change in independent variable as a function of the change in independent variable holding all other variables in the model constant.

3.3.6 Description of variables

The dependent variable is adoption of SWC which is expressed as dummy variable; 1 for adopter and 0 for non-adopter. The independent variables and their brief description are depicted in Table 3.

Table 3: Description of independent variable that affecting the adoption of SWC technologies

Variable	Code	Type	Description with Measurement unit	Expected sign
Age	HHAGE	Continues	Age of household heads (in years)	±
Sex	HHSEX	Dummy	1 for male and 0 otherwise	±
Family size	FAMSZ	Continues	Size of households (in numbers)	+
Education	HHEDU	Categorical	0 for unable to read,1foronly read and write ,2 for formal education (primary and secondary school)	+
Perception of soil erosion as problem	PERSO	Dummy	1 if erosion is perceived, 0 otherwise	+
Perception on SWC technologies profitability	PERTEC	Dummy	1 if perceived profitable, 0 otherwise	+
Participation of off-farm activity	PARTOFF	Dummy	1 if participate in off-farm work, 0 otherwise	-
Livestock ownership	TLU	Continues	Total livestock availability TLU unit	-
Farm size	FARSZ	Continues	Total area of farm (cultivated land, grazing land, woodland, and bare land); (in ha)	±
Land tenure	LADTE	Dummy	1if has feeling land ownership ,0 otherwise	+
Farm location	FARLOC	Continues	Average distance to home to farm area(in walking minutes	-

Labour availability	LABAV	Continues	Number of full time HH member engaged on farm activity	+
Extension service	EXTSER	Dummy	1 if farmer contact with extension worker,0 otherwise	+
Training on SWC practices	TRAN	Dummy	1 if the farmer has been trained ,0 otherwise	+
Market distance	MAKT	Continues	The distance of home to nearest market in (Walk hr)	-
Access to credit	CRDT	Dummy	1 if received credit, 0 otherwise	+

Source: Derived from review of related literature,

CHAPTER FOUR

4. RESULT AND DISCUSSION

This chapter describes the descriptive and econometric model result of the study. The descriptive statistic result includes demographic and socio-economic characteristics, implemented SWC technologies and implementation approach, farmer's perception to soil erosion and control measures, SWC adoption status,food security status and copying mechanism in case of food insecurity. The econometric analysis section result shows the determinant factors of adoption of SWC technologies and food security of farming household and also the role of SWC technologies to household food security.

4.1Descriptive Statistics

4.1.1 Demographic and Socio-economic characteristics of study participants

4.1.1.1 Sex, education status and off-farm participation of farm households

A total of 423 respondents were included for the analysis of contribution of SWC practices to HHFS from 3 agro-ecology zone of Ensaro *Woreda*. Among the study participants, 77.3% and 22.7%were male headed and female headed households respectively.Fifty seven percent of HHH were unable to read and write and only 19.9 % of farming household was attending formal education that was primary and secondary education. Out of the total respondents,only22.7 % of the HHH were participating on off-farm activity(Table 4).Petty trade and daily labor were the major source of off-farm activity.

Table 4: Distribution of Sampled Households by Sex, education and off-farm participation

Category	Characteristics	Number	Percent
Sex of HHH	Female	96	22.7
	Male	327	77.3
Education status of HHH	Unable to read and write	241	57.0
	Only able to read and write	98	23.1
	Formal education	84	19.9
Off-farm activity	Yes	96	22.7
	No	327	77.3

Source: own survey, 2019

4.1.1.2 Age, family size, livestock and landholding of household head

Age of the respondents in the study *Woreda* ranged from 20 to 80 and the mean ages of the respondents were46.55years with standard deviation of 10.89. The family size of sampled respondents also ranged from 2 to 12 and the average family size was around 4.66 (5) persons with standard deviation of 1.69. Total livestock varied from 0 to 11.93 with mean of 2.83 Tropical livestock unit (TLU).Regarding labor availability on farming, it varies ranging from 0 to 7 with mean of 1.56 persons. The average land holding size of the sampled households was 1.26 hawith minimum, maximum and standard deviation of 0.25 ha, 3.5 ha and 0.64 respectively (Table 5).

Table 5: Distribution of Sampled Households by Age, Family size, TLU,laborand Land size

Category	Minimum	Maximum	Mean	Stand.dev
Age (year)	20	80	46.55	10.89
Family Size	2	12	4.66	1.69
Labor availability	0	7	1.56	0.87
Monthly income (ETB)	600	2000	114.47	266.75
livestock (TLU)	0	11.93	2.83	1.56
Total land size (ha)	0.25	3.5	1.26	0.64

Source: own survey, 2019

4.1.1.3Institutional and farm characteristics of the respondent

Amhara credit and saving institution is the only institutions who serve credit for the communities in the study area.And also, about 43% of the HHH were used credit .The majority of the HHH take credit for purpose of purchased fertilizer but not any one were in use credit for purpose of SWC technologies implementation.Out of the respondent, 29.8 % of the HHH were taking training on SWC measures and implementation techniques. At *woreda* level, land administration and environmental protection office were distributing land certification for farming household as a result,all farmers had land certificate and majority of the farmers received map of farming area. About 83% of the household head were had feeling land ownership because of land certification with land map.Farmers may have their plot located in different place.Some very closes to their homes while some may be located far from home. This result revealed that farm location were in range of 10 minute to180 minute with mean of

47.8minute.When compared agro-ecological zone farm location from their homstead Dega agro- ecology were relatively smaller distance than the other agro-ecology. In study area ,there were only one markets on the lemi town . The farming household were travlled with minimum of ½ hr to 4 hours for purchasing agricultural inputs and selling their product.

Table 6; Farm and institutional characteristics of study participant

Category	Characteristics		Number	Percent
SWC training	Yes		126	29.8
	No		297	70.2
Credit	Yes		182	43
	No		241	57
Extension service	Yes		236	55.8
	No		187	44.2
Land tenure	Yes		351	83
	No		72	17
	Min	Max	Mean	Stand .dev
Farm location minute	10	180	47.8	51.06
Distance from market hr	½	4	2.23	0.93

Source: own survey, 2019

4.1.2 Type of introduced SWC technologies and implementation approaches

All respondents used crop rotation as measure of SWC practices. Among implemented technologies, stone bund, compost and stone-faced soil bund were the most implemented technologies on cultivated land. It was 54.0 %, 23.4 % and 20.6% of the technologies respectively (Table 7).And also, traditional conservation measures were implemented on their cultivated land such as kab, and Furrow. Whereas, area closure, afforestation and hillside terrace were used to hillside protection and conserving degraded lands .The result shows, physical conservation measures mainly dominated in the study area .Similarly to this study , Asnake &Elias, (2017) reported, physical measures mainly implemented in Guba Lafto *Woreda*, North Wollo. When compared to agro-ecological zone, grass strip, cut of drain and check dam were dominated in Dega (Wekelo) agro-ecology. Whereas, stone bund, stone-faced soil bund and compost were dominating conservation measures on Woyinadega (Karamba) and kolla (Beressa) agro- ecology.

According to focus group discussion and personal observation in karamba and Beressa *kebele* these *kebeles* had high access of stone to construct much bunds and the slop of the land were required mainly physical measures. Whereas, in Wokelo *kebele*, there was shortage of stone to construct much physical measures and the slop of the land were mostly flat. On the other hand,out of the implemented technologies, only 2.6 % of the farming household used water harvesting systems that were preparation of water pond. However, due to kola agro-climatic condition, there was shortage of water resource which require different type of water harvesting techniques recommended but there were unsatisfactory implementation in study area. According to key informant interview, EWADO were distributing water harvesting technologies (Geomembrane) by 30/70 credit principle but effectiveness and adoption of the Geomembrane were very poor because of farmer's perception on water harvesting technologies and implementation being very limited. Some farmers used Geomembrane as construction of livestock shelter called "*Tenbera*".

Table 7: Commonly implemented SWC technologies stratified by agro-ecology

SWC technologies	**Wekelo**	**Karamba**	**Beressa**	**Total**
	Number &(%)	**Number&(%)**	**Number&(%)**	**Number&(%)**
Stone bund	30(13.2)	121(53.1)	77(33.8)	228(54.0)
Stone faced soil bund	6(7.0)	38(43.0)	43(50.0)	87(20.6)
Grass strip	26(92.9)	2(7.1)	0(0.0)	28(6.6)
Check dam	37(50.7)	21(28.8)	15(20.5)	73(17.3)
Waterway	28(37.8)	28(37.8)	18(24.3)	74(17.5)
Cut of drain	24(41.4)	20(34.5)	14(24.1)	58(13.7)
Compost	6(6.1)	51(51.5)	42(42.4)	99(23.4)
Water pond.	1(0.8)	1(0.6)	9(6.8)	11(2.6)
Crop rotation	124(100)	167(100)	132(100)	423(100.0)
Total	124(29.3)	167(39.5)	132(31.2)	423(100)

Source: own survey, 2019

Fig. 3. Implemented technologies (Source: own photo, 2019)

According to qualitative data source, after harvesting and yearly public campaign periods the farmers constructed SWC activity on their own land mainly using family labor and through traditional practices called ‘debo’. This implies in the study area the majority of the farmers used SWC implementation on their farm land by individual level approached than Watershed level Similar to this study, in Wollo, farmers used debo / wenfel to construct SWC practices on their farm land (Amare, 2007).

4.1.3 Public campaign participation and its constraints

The participation of different actors at different phases of SWC practices enhances the possibility of achieving sustainable SWC outcomes. For the last many years governmental and recently sustainable land management projects facilitating SWC measures to recovering land degradation and reducing level of soil erosion.This study revealed all farmers not offered any incentives for participation in public campaign SWC activities.

Out of the total respondent, 87.7% of the household head or any member of the family participate on yearly public SWC campaign from which 57.2 % were participating by their interest .Whereas, 42.8% were participating without their interest (Table 8). Similarly to this study, Akkaraboyina & Tareke, (2018) reported, 41.0% of the farmers participated in the SWC practices by without their interest. According to the information gathered from the KII,concerned persons of the government bodies and local *kebeles* leaders had facilitating without their interest to participate on public campaign. FDG indicated, Farmers have different preferences with regard to SWC approaches some farmers expected cash incentives from the government for participating on public campaign and some of them invest their labor for their farm land rather than public campaign.

During FDG one farmers opposing public campaign implementation approach"*when he took land by water ,the owner of the land sitting in Addis Ababa to collect money ,why not investing my labor to conserving his land, why not government enforced and punished the owner of the land rather routinely pushing me to participating on SWC ".*

This implies there was gap between the community and government towards SWC practices implementation approach, this way of participation had created a challenge for the sustainability and quality of SWC practices.

In this findings, the majority of the respondent perceived that major constraints for implementation of SWC measures were that it required too much labor, the farmers had low perception of soil erosion as a problem and lack of monitoring land management system and also 5.2% were other constraint for public campaigns: such as implementation approach.Out of the total study participant, 64.5% of the farming households conducted maintenance on their SWC measures. During my observation time, after harvesting period some of the constructed measures was damaged by livestock at a result routine maintenance was required.

Table8**:** Household Public campaign participation level and constraints

Characteristics	Response	Number	Percent
Participating on public campaign SWC practices	Yes	371	87.7
	No	52	12.3
Participation way	Voluntary	222	57.2
	Without their interest	166	42.8
	With incentive (Cash,FFW,)	0	0
Constraint to implement SWC technologies	Difficult to constructing introduced technologies	44	10.4
	Required too much labor to construct bund	207	48.9
	Physical measures decrease farm land /difficult to plow	39	9.2
	Poor agricultural extension service	60	14.2
	Land owners not understand impact of erosion on crop	93	22.0
	Other	22	5.2
Soil and water conservation structures maintained	Yes	273	64.5
	No	150	35.5

Source: own survey, 2019

4.1.4 Perception of respondents for soil erosion as a problem and technologies profitability

Regarding farming HHH perception about soil erosion as a problem, the survey result showed that 82% of farmers perceived soil erosion as a problem, and they reported that high rainfall/high run-off, deforestation and steepness of the land were the dominant cause of soil erosion which covers 54.6%, 38.6 % and 23.9% of the response, respectively. But adoption level of the introduced SWC technologies was unsatisfactory because the majority of the respondent was non-adopter. Similarly to this result, Mekuriaw *et al*, (2018) reported that, high percentage of farmers' awareness and using SWC structure does not mean that so much land protected.

About 91.7% of the HHH perceived SWC technologies profitability from the total respondents, 44.4% of farmers evaluate the way of profitability through soil erosion rate decreasing overtime due to SWC practices, 45.8% were observed productivity difference between conserved and non-conserved land. This implies farmers observed SWC technologies profitability in their farm land by different way. Also 84.4 % of the farmers believed that erosion could be halted.

Table 9: Perception of respondents for soil erosion as a problem and technologies profitability (Totals may exceed 100% due to multiple responses).

Characteristics	Response	Number	Percent
Believe soil erosion problem in their area	yes	347	82.0
	No	76	18.0
Main causes of soil erosion	Heavy rainfall/ high run-off	201	54.6
	Deforestation	142	38.6
	Improper plough	23	5.4
	Overgrazing	14	3.8
	Steepness of the land	88	23.9
	Soil being to erodible	51	13.9
	Improper construction of ditch	14	3.8
	Other	11	3.1
Rate of soil erosion overtime	Increase	87	23.9
	Moderate	121	32.4
	Decrease	166	44.4
Believe that soil erosion can be controlled	Yes	357	84.4
	No	66	15.6
Believe profitable of SWC measure for long term	Yes	388	91.7
	No	35	8.3
Profitability way of SWC technologies	Erosion reduction	310	78.5
	Improve land productivity	181	45.8
	Soil fertility maintenance	124	31.4
	To increase moisture retention	47	11.9

Source: own survey, 2019

4.1.5 Adoption status of SWC technologies

Out of the total study participants, 60.8% of farming household was non-adopter and 39.2 % were adopter. This implies majority of the HH in the study area were implemented less than 50% of the recommended technologies that were suitable for their agro-ecologies and/or can't performed maintenance on SWC technologies. When compared to *kebele* wise, adoption status in BeressaandKaramba*kebele* was highest as compared to Wekelo*kebele* (fig 4).

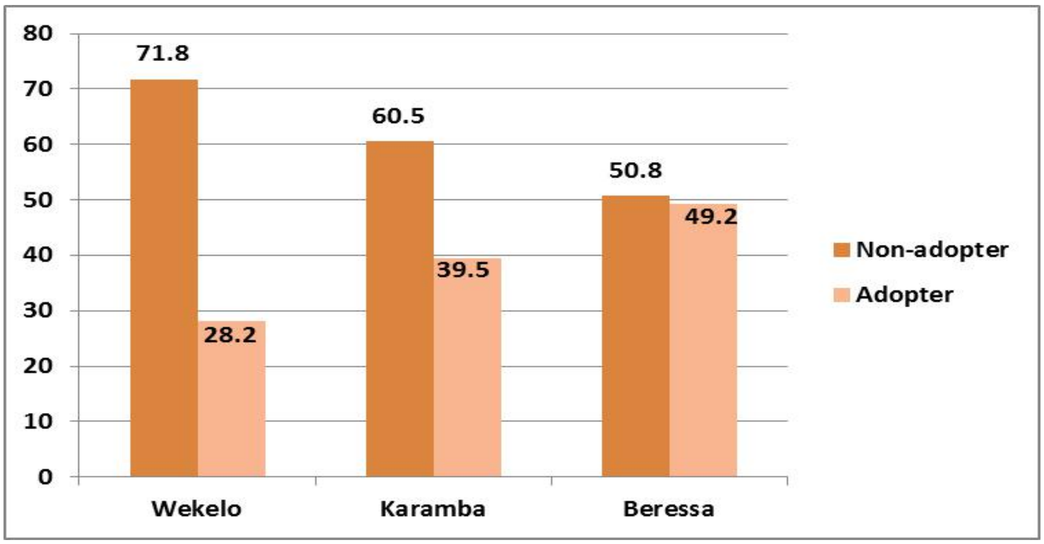

Fig. 4. Percentage of SWC technology adoption stratified by agro-ecology

4.1.6 Household food security status and copying mechanism

Results on household food security status by using HHFB model showed that, out of the total study participant, 73.3% were food secure and 26.7% were food insecure (Fig. 5). The total calorie available per adult equivalent per day varied from 835.06 to 8814.49 with a mean of 2772.2. With regard to HHFS, this study reveals that majority of HH in Ensaro *Woreda* were food secure.Similarly to this study, the majority of the household were food secure in Northern Gonder Amhara Region (Sisay,Degsew & Wuletaw,2015).Contradictory to this finding,there are studies (Genene & Wegaye , 2010;Negash & Alemu 2013 and Siraje& Bekele, 2013) which showed high prevalence of food insecurity in rural household.

According to EWADO, risk prevention and preparedness department reported there had not any identified *kebele* to fill food gap which had food shortage. However, this research confirmed 26.7% out of the total participant were below the medically recommended level of calorie per adult equivalent (2200kcal/day/person) for Ethiopia (NFS, strategy, 2002).FDG and KII data source confirmed September and October were the period of few farmers had food gap mainly and they also indicated rainfall variability and incidence of pests for pulse products were major cause of food shortage. Whereas, land shortage and high cost of fertilizer were the other suggested factors for shortage of food in the study area.

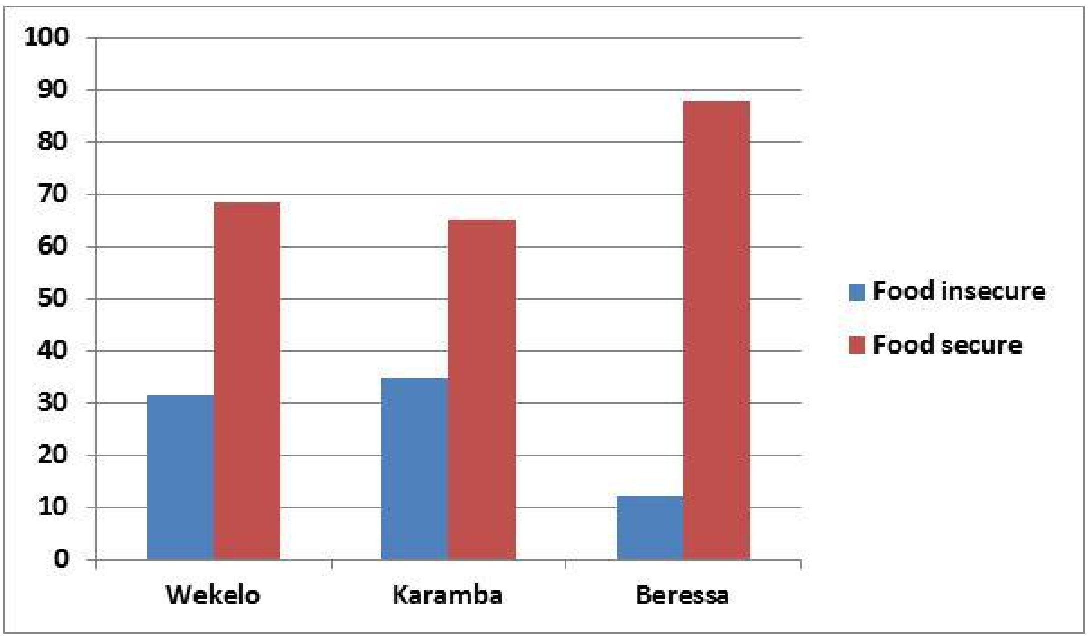

Fig. 5 . Percentage of food security status stratified by agro-ecology

Table 6 shows that, about 44.2 % of food insecure household were mainly used relied on less preferred and less expensive food such as red sorghum its local name called *Wodehaker* and 32.7 % were borrowing food from friend or relatives, 26.5 % purchased food on credit and 25.7 % work on daily labor, 9.7 % reduce amount at meal time and 3.5 % sell their livestock were the major copying strategies for food insecure household.Similarly to this study,Mohamed (2017) reveled farming household used sale of livestock, agricultural employment, and migration to other areas, requesting grain loans, sales of wood or charcoal, small scale trading and limiting size and frequency of meal as copying mechanism in case of food insecurity .

Table 6: Household copying mechanism in case of food shortage (Totals may exceed 100% due to multiple responses).

Coping mechanism	Number	Percent
Rely on less preferred and less expensive food	50	44.2
Borrow food from a friend or relative	37	32.7
Purchase food on credit	30	26.5
Daily labor	29	25.7
Limit amount size at meal times	10	9.7
Selling livestock	4	3.5

Source: own survey, 2019

4.2 Econometric model result

4.2.1 Determinant factors that affecting adoption of SWC practices

In order to determine the adoption of SWC technologies there was total of 16 explanatory variables used from demographic and socio-economic factors, HHH perception, farm characteristic and institutional factors. The logistic regression output,marginal effect (dy/dx) result, shows that distance to market, HHH perception to profitability of technologies and training on SWC technologies were positively significant factors for adoption of SWC technologies but the remaining explanatory variables have no significant effect on adoption of technologies at 5% significant level. Detailed explanation for each explanatory variable with adoption of SWC technologies were depicted below (Table 10).

Table 10: Logistic model for adoption of SWC technologies in Ensaro *Woreda*

Adoption SWC	Odds Ratio	dy/dx	Robust Std. Err.	Z	P>|z|	[95% Conf. Interval]	
HHSEX	.99488	-.001213	.2717537	-0.02	0.985	.5824559	1.699332
HHAGE	1.004692	.0011059	.0103522	0.45	0.650	.9846059	1.025189
HHEDU	1.030235	.0070363	.1468843	0.21	0.835	.7790713	1.36237
FAMSZ	.8966297	.0257748	.0647994	-1.51	0.131	.77821	1.033069
LABAV	1.139071	.0307592	.1501217	0.99	0.323	.8797682	1.4748
OFFRM	1.379301	.0772559	.3704054	1.20	0.231	.8148399	2.3334778
TLU	1.039426	.0091345	.0826145	0.49	0.627	.8894867	1.214641
PERSO	.9771267	0054754	.2899595	-0.08	0.938	.5462095	1.748004
LADTE	.8221525	.0468867	.2382037	-0.68	0.499	.4659424	1.450683
FARLOC	1.003791	.0008939	.0021	1.81	0.070	.999684	1.007916
EXTSR	1.096376	.0217043	.2445556	0.41	0.680	.7080956	1.697567
TRAN	1.603305	.1133228	.3753728	2.02	0.044**	1.013279	2.536899
CRDT	.8761325	-.03116	.1903985	-0.61	0.543	.5722545	1.341375
DMAR	1.455319	.0886367	.1778723	3.07	0.002**	1.145309	1.849243
TLDSIZ	1.016175	.0037904	.1767299	0.09	0.926	.7226541	1.428917
PERTEC	2.741169	.2052351	1.207885	2.29	0.022**	1.155732	6.501513
Cons	.0816004		.0661697	-3.09	0.002	.0166515	0.3998815

Number of Obs = 423 **p value < 5%
Wald chi2(16) = 31.39
Prob> chi2 = 0.0120
Pseudo R2 = 0.0563
Log pseudo likelihood = - 267.38746

4.2.1.1 Demographic and Socio-economic factors

Demographic and Socio-economic factors explanatory variables including in the model were sex,age,family size,education status, total livestock, labor availability, and off-farm activity of household head.But all demographic and socio-economic characteristic had positive relation with adoption of SWC technologies except sex of household it was inversely affects adoption of SWC technologies. Whereas, all socio-economic factors did not have significant impact on adoption of SWC technologies in this study(Table 10).

Similarly to this study , Mekuriaw et al., (2018)confirmed that, age, sex, total livestock and education status of household head did not have significant impact on adoption of SWC technology. In contrary to this finding,various researchs (Amsalu & Graaff, 2006; Asfaw&Neka, 2001; Mekonnen & Abiy, 2014; Teshome, de Graaff, & Kassie, 2016; Mango et al., 2017 and Mountain & Park, 2018) reported significant level of socio -economic status on adoption of SWC technologies.

4.2.1.2 Household head perception

Understanding farmers' perception of soil erosion and its impact is important in promoting SWC technologies. This result shows that, majority of the farming HHH perceive soil erosion as a problem on their local area and they recognized high rainfall, deforestation and steepness of the land were the dominated cause of soil erosion. And also, majority of the HHH evaluated soil erosion level decreased through time because of conservation measures but farmers perception were not significant factors for this study. Similar to this finding, other studies (Tadesse & Belay, 2004 ; Tefera & Sterk, 2010; Adugna, 2015 ;Jaleta M. *et al.* 2016 ; Teshome *et al.*, 2016) reported insignificant level of soil erosion perception. Whereas, farmer perceived about long term profitability of technologies was found to have positive relation with adoption of SWC technologies and it was statically at 5% level of significant. The marginal effect shows that, technologies profitability perceivers HHH were 20.5%(0.205*100) more adopters of SWC than non-profitability perceiver, held all factors were constant. This implies that there is high probability of investing SWC technologies to their farm land in the case of the households understanding the long-term outcome of the conservation measures rather than those taking perception of soil erosion as a problem only. Similarly, study done by Amsalu& Graaff , (2006) showed that there is a significant association of farmers technologies profitability perception with adoption of SWC technologies.

4.2.1.3 Farm characteristic

The current study result shows that farm location, farm size and land tenure security were positively associated with adoption of SWC technologies but did not had significant association with adoption of SWC technologies in Ensaro *Woreda*. Similar to this study, Amsalu & Graaff,(2006) reported that land tenure system are insignificant in highland part of Ethiopia because all farmers were feeling the sense of land ownership since they got land certification but the study conducted by Tefera & Sterk, (2010) in Fincha watershed western part of Ethiopia result shows, land tenure were positively significant to conservation measures.

When farmers believe the profitability of technologies and also agriculture was the only source of livelihood, farmers' farm size and farm location cannot be a constraint for adoption of SWC technologies. Contrary to this,Amsalu& Graaff, (2006) and Teshome, Graaff, & Kassie, (2016) reported that farmers who hold large farms are more likely to invest in conservation. Also, Gebremedhin & Swinton (2003) reported when increasing farm location from farmers homestead adoption rate should be decreased.

4.2.1.4 Institutional factors

The logistic regression model result shows that, both distance to market and training on SWC technologies were significant factors for adoption of SWC technologies.Whereas, contradictory to our expectation access to credit were negatively, and agricultural extension service there was positively associate with the adoption of SWC technologies but had not significant effect with adoption of SWC technologies.

Agricultural extension service and training on SWC were the basic tools for farmers to get awareness about SWC, the mechanism how to implement it and improve production methods (Asfaw & Neka, 2017).According to key informant interview finding, each *kebele* had total of 5-6 agricultural extension officer and also majority of the household get agricultural extension advice. But the current study result reveals that, agricultural extension service was insignificant variable on adoption of SWC technologies.Household head who were attaining SWC technologies training were,11.3 %(0.113*100) more likely to adopt conservation technologies than non-trained household, holding other factor constant. According to qualitative data source, agricultural development office provide SWC training for selected farming household head for purpose of guiding public campaign work for their local area and to conserve natural resource for sustainable way. Similarly to this study, there are studies (Nkegbe, 2011; Teshome, Graaff, & Kassie, 2016; Mango et al., 2017) which showed significant level of training on adoption of SWC technologies.

The lack of access to market were one of the factors that were negatively affected adoption of SWC technologies due to increased production costs and unsatisfactory profit margins farmers get (Gebremedhin & Swinton, 2003). In contrary to this, the current study marginal effect result shows that when distance to market increase by 1hr, being adopter of technologies was increased by 8.8 % (0.088*100) while other things was held constant . The possible reasons for this could be the presence of only one market for 13 *kebeles* farming household for selling and buying agricultural outputs at *Woreda* level.This implies the farming household was suffering to travel long distance to get market access and also these factors may pushed HHH investing their time for managing their land rather than frequently travelled to market. The other possible reason for better adoption of SWC technologies in kolla and Woyinadega agro- ecology zone were slope of land and access to input for physical measures (stone).

4.2.2 Association of SWC adoption and food security status

Out of the total respondent,83.13%SWC technologies adopter household were food secured but only 16.87% were food in-secured. On the other hand, only 66.93%of non-adopters were food secured and 33.07 % were food in-secured (Table 11). The Pearson chi-square result shows there were significant association between SWC technologies adoption and household food security status in Ensaro*Woreda*. Cross tabulation analysis implies that greater proportion of food secured household were SWC technologies adopter and also chi-square results showed that had there were significant association between adoption of SWC technologies and household food security.

Table 11: Association of SWC technologies adoption with food security

SWC adopters	Food security situation		Total
	Food secured	Food in-secured	
Adopter	138	28	257
	83.13	16.87	100.0
Non adopter	172	85	166
	66.93	33.07	100
Total	310	113	423
	73.29	26.71	100

Source: own survey, 2019

Pearson chi2(1) = 13.5306   P = <0.0001

4.2.3 Determinant factors that affecting household food security

The logistic regression analysis below shows that, adoption of SWC technologies, family size, total land size and distance to market were the major determinate factors that affect HHFS of farming household at 5% significant level.Whereas, all other variables did not had significant association with household food security status.

Adoption of SWC technologies was found to have positive relation with household food security and it was statically significant even 1% level of significant the marginal effect show as the household who adopt SWC technologies on their cultivated land were, held other factors constant, 14.8 % (0.148*100) higher chance of food security than non-adopter household. This implies adoption of SWC technologies generate substantial benefit in reduction of soil erosion, improve agricultural productivity, some of them were collected livestock feed from closure area and conserved bund and enhance soil fertility that in turn has positive benefits on food security.

There are various studies which reveal similar findings. For instance, Haregeweyn *et al.*,(2015); Melaku *et al*.,(2018) reported adoption of SWC technologies reduce soil erosion, Vancampenhout, Nyssen, & Gebremichael, (2006), reported increased crop yield, and also Shiene, (2012) confirmed SWC has a significant role in maintaining soil fertility, maintaining agricultural production, restoring vegetation cover, and mitigating anthropogenic land degradation.

Family size as measure as adult equivalent was the second determinant factors that inversely affecting household food security status and it was statically significant even 1% significant level. The marginal effect shows as family size increase by 1 member, the probability of food secured decreased by 10.2% (0.012*100) while other things were held constant.The possible explanation to this was that the majority of the study participant couldn't participate on off-farm activity, as a result, household food and non-food expenditure mainly covering from agricultural activity creates more pressure on HHFS when a family size increase. Similarly to this result,(Siraje & Bekele 2013;Mesele, Suneetha, & Tigga ,2018)reported,the negative effect of family size on HHFSS.

On the other hand, total land size which was another factor that affecting household food security.When increased land size by 1 hectare, being food secure was increased by 13.1% (0.131*100), other factors were held constant.This implies that when the HH had larger land size produced more food for household consumption and for sale and better chance to food secure than those having relatively small size. This is in line with study done in North Tigray region which confirms similar result (Mesele, Suneetha, & Tigga , 2018).

Table 12 :Logistic model determinant factors for household food security in Ensaro *Woreda*

Food security	Odds Ratio	dy/dx	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]	
HHSEX	1.26634	.0421153	.3977971	0.75	0.452	.6841657	2.343902
HHAGE	9887455	-.0019491	.0133263	-0.84	0.401	.9629684	1.015213
HHEDU	.9759591	-.0041906	.1611885	-0.15	0.883	.7060704	1.34901
FAMSZ	.5528543	-.1020609	.0591589	-5.54	<0.0001**	.4482567	.6818591
LABAV	.9076047	-.0166949	.1584057	-0.56	0.579	.6446666	1.277786
TLU	1.0774	.0128382	.0905175	0.89	0.375	.913826	1.270254
LADTE	1.217369	.0350902	.398864	0.60	0.548	.6405169	2.313734
FARLOC	.99862	-.0002378	.0024242	-0.57	0.569	.9938801	1.003383
EXTSR	.6398317	-.0757767	.1733269	-1.65	0.099	.376253	1.088057
ADOP	2.483448	.1481701	.716499	3.15	0.002**	1.410831	4.371546
CRDT	.7856937	-.0419196	.2020753	-0.94	0.348	.4746022	1.300699
DMAR	1.460607	.0652414	.2013928	2.75	0.006**	1.114724	1.913813
TLDSIZ	2.138577	.1309023	.4561554	3.56	<0.0001**	1.407878	3.248516
INCM	9999311	-.0000119	.0004706	-0.15	0.884	.9990093	1.000854
-cons	7.57787		6.18352	2.48	0.013	1.530978	37.50811

Number of obs = 423
Wald chi2(14) = 61.90
Prob> chi2 = 0.0000
Pseudo R2 = 0.1610
Log pseudo likelihood = -205.97706
**P-value < 0.05

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

This research, which is intended to assess contribution of SWC practices to household food security in Ensaro *Woreda*, Amhara National Regional State,Ethiopia.From the result of this study, it can be concluded that Physical measures were the dominated conservation measures in study area.Crop rotation, stone bund, stone face-soil bund, check dam, grass strip, cutoff drain, and waterway and compost application were the major identified SWC measures on cultivated land in Ensaro *Woreda*.Using family labor and through traditional practices were the dominated SWC implementation approaches for their cultivated land. However, public campaign was also focused mainly on gully rehabilitation and hillside protection.

There were observed different soil and water conservation adoption status between three agro-ecology zone in Ensaro *Woreda*. Woyinadega and Kolla agro-ecology was better adopter of SWC technologies than Degaa gro-ecology.Regarding determinant factors, HHH who perceived long term technologies profitability, far from the market and got SWC training were more adopter of SWC technologies than the others. This implies household head perception and institutional factors were significantly determining adoption of soil and water conservation. But farm characteristics, demographic and socio-economic factors, were can not significant determine adoption of Soil and water conservation technologies,

On the other hand, the majority of the household in the study area were food secured;but there were about 26.7% food insecure household in study area. This implies the majority of the household achieve the recommended kilo calories available per day per adult equivalent for Ethiopia. Food insecure household in the study area develop their own Copying mechanism in case of food shortage. Borrow food from a friend or relatives, relying on less preferred and less expensive food, purchased food on credit and work as daily laborer were used as household major copying strategies in case of food shortage. Adoption of SWC technologies, land size, distance to market and family size were factors that significantly determine household food security in Ensaro *Woreda*.

There was significant positive association between SWC technologies adoption and household food security. The household who adopt SWC technologies were better food secured than non-adopter of SWC technologies.

From the conclusion made by the current study, it can be recommended that

- It is important to improve HHH perception about technologies profitability the government by arranging experience sharing program using farmers who practice SWC technologies and become profitable.
- Governmental and non-governmental sustainable land management facilitators should provide practical training on SWC technologies measures and way of implementation.
- To improve adoption of SWC technologies, the farmers properly attending SWC training and implement effective SWC measure suitable for their agro-ecologies.
- It is also important to improve household food security status by monitoring, evaluating and facilitating recommended SWC technologies implementation.
- To improve household food security government should strength family planning program and also the household must plan to balance family size with available resource.
- Finally, I would like to recommend similar studies to be conducted for agro-ecology zone soil erosion level and assure the quality of implemented soil and water technologies with standard.

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APPENDICES

Annex 1, Marginal effect after logistic regression model of SWC technologies

Variable	dy/dx	Std. Err.	Z	P>z	[95% C.I.	]	X
HHSEX*	-.001213	.06457	-0.02	0.985	-.127763	.125337	.77305
HHAGE	.0011059	.00243	0.45	0.650	-.003666	.005878	46.5532
HHEDU	.070363	.03368	0.21	0.835	-.058972	.073044	.628842
FAMSZ~e	.0257748	.01709	-1.51	0.131	-.059264	.007715	4.6643
LABAV~e	0307592	.03111	0.99	0.323	-.030219	.091738	1.55556
OFFRM*	.0772559	.06543	1.18	0.238	-.050979	.205491	.22695
TLU	0091345	.01879	0.49	0.627	-.0277	.045968	2.83475
PERSO~n*	0054754	.07034	-0.08	0.938	-.143338	.132388	.822695
LADTE~e*	.0468867	07016	-0.67	0.504	-.184395	.090622	.829787
FARLOC~n	.0008939	.00049	1.81	0.070	-.000074	.001862	47.8833
EXTSR ~e*	.0217043	. 05251	0.41	0.679	-.081205	.124613	.55792
TRAN~c*	.1133228	.05668	2.00	0.046	.002241	.224405	.297872
CRDT~e*	-.03116	.05106	-0.61	0.542	-.131237	.068917	.43026
DMAR	.0886367	.02889	3.07	0.002	.032019	.145254	2.23522
TLDSIZ~e	.0037904	.04108	0.09	0.926	-.076728	.084309	1.25843
PERTEC~y*	.2052351	.07255	2.83	0.005	.063034	.347437	.917258

(*) dy/dx is for discrete change of dummy variable from0 to 1

Annex 2 Variance inflation factor for discrete and continuous variable for adoption of SWC technologies

Variable	VIF	1/VIF
1.HHSEX	1.18	0.845350
HHAGE	1.19	0.839982
HHEDU		
1	1.16	0.863806
2	1.27	0.790336
FAMSZ	1.42	0.706148
LABAV~e	1.36	0.737414
1.OFFRM~e	1.13	0.881315
TLU	1.41	0.710197
1.PERSO~n	1.13	0.886733

1.LADTE~e	1.11	0.897006
FARLOC	1.11	0.903950
1.EXTSR~e	1.20	0.836728
1.TRAN~e	1.15	0.871629
1.CRDT~e	1.09	0.913328
DMAR	1.19	0.841082
TLDSIZ	1.20	0.831262
1.PERTEC~e	1.07	0.934999
Mean VIF	**1.20**	

Annex 3:Model goodness-of-fit testfor adoption of SWC

Logistic model for SWC adoption, goodness-of-fit test
Number of observations = 423
Number of covariate patterns = 417
Pearson chi2(399) = 405.42
Prob> chi2 = 0.4014

Annex 4: Marginal effect after logistic regression of food security

Variable	dy/dx	Std. Err.	Z	P>z	[95% C.I.]		X
HHSEX*	.0421153	.05775	0.73	0.466	-.071081	.155312	.77305
HHAGE	-.0019491	.00232	-0.84	0.400	-.006492	.002594	46.5532
HHEDU*	-.0041906	.02844	-0.15	0.883	-.059934	.051553	.628842
FAMSZ	-.1020609	.01797	-5.68	0.000	-.137276	-.066846	3.98783
LABAV	-.0166949	.03015	-0.55	0.580	-.075791	.042402	1.55556
TLU	.0128382	.01449	0.89	0.376	-.015567	.041244	2.83475
LADTE~e*	.0350902	.06036	0.58	0.561	-.083208	.153389	.829787
FARLOC	-.0002378	.00042	-0.57	0.570	-.001058	.000582	47.8833
EXTSR*	-.0757767	.04397	-1.72	0.085	-.161963	.010409	.55792
ADOP*	.1481701	.04232	3.50	0.000	.06523	.231111	.392435
CRDT*	-.0419196	.0449	-0.93	0.351	-.129923	.046084	.43026
DMAR	.0652414	.02399	2.72	0.007	.018227	.112255	2.23522
TLDSIZ~	.1309023	.03683	3.55	0.000	.05871	.203094	1.25843
INCM	-.0000119	.00008	-0.15	0.884	-.000171	.000147	114.473

(*) dy/dx is for discrete change of dummy variable from0 to 1

Annex 5: Variance inflation factor for discrete and continuous variable for food security model

Variable	VIF	1/VIF
1.HHSEX	1.17	0.853324
HHAGE	1.24	0.806509
HHEDU		
1	1.14	0.873923
2	1.24	0.804664
FAMSZ	1.49	0.670321
LABAV~e	1.35	0.741060
TLU	1.36	0.736428
1.LADTE~e	1.11	0.901369
FARLOC	1.12	0.893768
1.EXTSR~e	1.12	0.890257
1ADOP ~r	1.05	0.950746
1.CRDT~e	1.07	0.932841
DMAR	1.20	0.833376
TLDSIZ	1.20	0.835620
INCM	1.10	0.905607
Mean VIF	1.20	

Annex 6:**Food Composition Table for Use in Ethiopia**

Food item	Local name	Kcal/kg
Tef, Eragrostistef (Zucc.)Trott.	T'yef,dibilliq	3589
Corn (maize) ,Zea mays L. :white, whole grain	Beqqollo, nech	3751
Wheat, Triticumvulgarevill.: white ,whole grain	Sinidye,nech	3623
Barely ,black,hordeumvulgareL;whole grain	Gebistiqure,	3708
Sorghum, Sorghum spp.: white, whole grain	Masyilla,nech	3592
Broad beans, ViciafabaL. :,whole,dried	Baqyla,difin	3514
Peas.field,Pisumsativum L.: whole, dried	Ater ,difin	3553
Chickpeas,Cicerarietinum L.: whole, dried	Shimnibira,difi	3723
Lentils, LenssculinarisMed.:,whole, dried	Missir,difin	3522
Vetch, Lathyrussativus L.: dried	Guwaya,dereq	3470
Milik ,cow ,fresh	Yelamwotetyalitefela	737

Source: Ethiopian Health and Nutrition Research Institute, 1998-1997

Annex 7: Adult Equivalent Conversion Factor

Age group	Male	Female
Below 10	0.6	0.6
10-13	0.9	0.8
14-16	1	0.75
17-50	1	0.75
>50	1	0.75

Source:Strock*et.al*.,(1991)

Annex 8:Total livestock unit conversion factor

Animals	TLU equivalent
Calf	0.25
Heifer	0.75
Cow and oxen	0.7
Donkey	0.5
Sheep and Goat	0.1
Chicken	0.01

Source strock*etal.,(*1991)

Annex 9:Research questionnaires

A QUESTIONNAIRE FOR THE SELECTED KEBELE HOUSEHOLD HEADS IN ENSARO *WOREDA*

Dear respondent,

The main objectives of this questionnaire are used to assess contribution of soil and water conservation practices to household food security in Ensaro*Woreda.*To the partial fulfillment of MSc. food security and development study program. Household head is the respondent of this questionnaire. Your responses to the questions are valuable and will be held in utmost confidentiality to be used only for the analysis of this research. In this Study, you and me would have a short discussion of about 20-30 minutes only and I am asking you to help us. You will not be identified by name in any case. If you accept to participate in this research, you will be doing so voluntarily and there will not be any monetary returns.

Code No.:______________________ Name of data collector:___________

Kebele_______________________ Date:_____________

I. Socio-economic and Demographic characteristics

1. Sex of respondent? A) Male B) Female
2. Age _____________year.
3. Education level Household head? A) Unable to read and write B) Only able to read and write C) Other (specify) level of education __________________
4. How many persons lived in your family? ___Total ,<10______,10-13 M__F___,14-16M____F______,17-50 M_____F___, > 50 M____F______
5. How many of them fully engaged in farming activity? __________
6. Do you involve in off-farm activities? A). Yes B). No

7. If yes, what type of off-farm activity you participated?

S.N	Activities	Monthly income
1	Petty trade	
2	Salary employment	
3	Handcraft	
5	Grain and livestock	
6	Charcoal making	
7	Casual labor	
8	Others	

8. Do you have own livestock? A). Yes B). No
9. If yes, indicate the number of livestock you have last year?

Type of livestock	Number of livestock	Remark
Cow /heifer		
Oxen/bull		
Goat		
Sheep		
Donkey		
Chicken		
Other (specify)		

10. What are the major source of your livestock feed?

A) Communal grazing lands B) Open access grazing resources C) Private grazing lands D) Crop residue and aftermath E) Others (specify) ____________________

II. Household head Perception

1. Do you believe soil erosion is a problem in your area? A) Yes B) No
2. If yes, what are main causes of soil erosion? (multiple responses are possible)
   A. Heavy rainfall/ high run-off
   B. Deforestation
   C. Improper plough
   D. Overgrazing
   E. Steepness of the land
   F. Soil being to erodible
   G. Improper construction of ditch

H. Others (specify) ______________________________________

3. What are the symptoms of the soil erosion problem? (multiple response is possible)

   A.) Decrease soil depth B.) Decreasing productivity C.) Visible rill/gully formation D) others, specify ________________________________

4. How do you see the rate of erosion since the Derg /over time of period?

   A) Increase B) Moderate C) Decrease

5. Do you believe that soil erosion can be controlled? A) Yes B) No

6. Do you or your family participating on SWC practices on your *kebele?* A)Yes B) No

7. If yes, how do you participating?

   A) Voluntary b) without their interest c) With incentive (Cash, FFW,)

8. Is there any SWC measurement implemented in your farmland? A) Yes B) No

9. What type of technology you used? To which farm plot?

SWC technologies	Homestead	Farm plot 1	Fram plot2	Fram plot 3	Farm plot 4	If yes,when invested first(year)
Stone bund						
Stone face Soil bund						
Check-dam						
FunyaJuu						
Grass strip						
Cut of Drain						
Waterway						
Crop rotation						
Compost						
Water pond						
Other						

10. Are your soil and water conservation structures maintained? A) yes B) No

11. Do you Believe SWC measurements are profitable for long term? A) yes B) No

12. If yes,how this profitability is expressed? (multiple responses are possible)

    A. Erosion protection

B. Improve land productivity
C. Soil fertility maintenance
D. To increase moisture retention
E. Other, specify _________________

13. What are the major constraints to implement SWC technologies? (multiple answers possible)
A. Difficult to constructing introduced technologies
B. Required too much labor to construct bund
C. Decrease farm land /difficult to plow
D. Poor agricultural extension service
E. Not understand erosion impact on crop
F. Others, specify______________

III. Farm characteristics

1. Total size of your farm ____________ha/timad/gemed

A) Cultivated land____B)Woodlotarea______C). Grazing area______D) Bare land___

2. What kind of slop of your cultivated land and how much of them use SWC measure?

Slop type	Totalhectare/Gemed	Conserved land (%)
Flat		
Moderate		
steep		

3. Is your land registered? A). Yes B). No C). I do not know

4. Have you received land certification? A). Yes B). No C). Do not know

5. Do you expect that you will use the land throughout your life time? A). Yes B) No

6. If you rent of land, who will be responsible for SWC?

A). Landowner's B). Tenant's C). Both D). No agreement E. Other

7. If you rent out of land, who will be responsible for SWC?

A). Landowner's B). Tenant's C). Both D). No agreement E. Other

8. If you share of land, who will be responsible for SWC?

A). Landowner's B). Tenant's C). Both D). No agreement E. Other

9. If you share out of land, who will be responsible for SWC?

A). Landowner'sB). Tenant's C). Both D). No agreement E. Other

10. Average minutes to require from home to farm area by walking? __________.
11. Have you seen differences in the productivity of farm lands between conserved plots and non-conserved plots? A.) Yes B.) No
12. If yes, how are they different? (Multiple responses are possible)
    A) Enhancing soil fertility B). Decreased soil erosion level C) .Increase level of productivity D) other_________________________

13 . Have you collected animal feed from the bunds and closed areas? A) Yes B) No

14. If yes, how big per year? ____________

15.What is your source of livestock water consumption? _________________

IV. Institutional characteristics

1. Did the extension agent visit you in the last cropping season? A).Yes B).No
2. If yes, frequency of visit?__________timeper year.
3. Did you get help or advice from extension agent about soil and water activities?
   A). Yes B). No
4. Have you ever attended a farmer-training course on SWC measures?
   A) Yes B).No
5. If yes, do you think the training was helpful for your Practical SWC work?
   A) Yes B) No
6. Do you have an access to credit?A). Yes B). No
7. If yes, Purpose of credit (multiple response is possible)
   A. To purchase fertilizer
   B. To purchase seed
   C. To purchase livestock
   D. For SWC
   E. For fattening
   F. To start-off/non-farm business
   G. Other, specify ________________
8. If no for question 6, why don't you have access to credit?
   A. No institution that provides credit

B. High interest rate

C. Lengthy procedure

D. Collateral requirement

E. Repayment terms are unfavorable

F. Since I have no shortage of money

G. Other, specify

9. How many hours required to did you buy your agricultural inputs and sell your product to the nearest market by walking? ___________hr.

V. Household Food security assessment and coping mechanism

Household food availability for the last oneyearDecember 2017 to December 2018

No	Commodit y	Annu al harves t (qt)	Purchas ed from market (qt)	Borr owe d (qt)	Food aid obtai n(qt)	Gift or remitt ance(qt)	losses due to grain pests, disaster, thievery (qt)	Rese rved for seed (qt)	Sol d(q t)	Give n to other s (qt)
1	Teff									
2	Maize									
3	Barely									
4	Wheat									
5	Sorghum									
6	Bean									
7	Pea									
8	Chickpea									
9	Lentil									
10	Oily seed									
11	Other									

1. Do you milk any animal(Cow) for the last year? A) Yes B).No
2. How many animals milked?______
3. How much milk was produced per day?________litter.
4. How long the they milked ?_______month
5. What major purpose is of milked? A) ConsumptionB) sale C) both D)other
6. Do you have a food shortage problem in your household in last year? A) Yes B). No
7. If yes, for how many months per year did your household face shortage of food and which month?

____

8. What is the cause of food insecurity? (Multiple responses are possible)
   A. Extreme variability in rainfall/Drought
   B. Incidence of pest, diseases, weed
   C. soil ferity decline
   D. other (specify)

9. Number of average meals per day in the household? ____________

10. What type of coping mechanism you used when you don't have enough food or money to buy food in your family? (Multiples response possible)

Coping mechanism	Rank
1. Rely on less preferred and less expensive food	
2. Borrow food from a friend or relative	
3. Purchase food on credit	
5. Limit amount size at meal times	
6. Restrict consumption order for small children to e	
7. Skip meals	
8. Send children to eat with neighbors	
9. Send household members to beg	
10. Selling charcoal	
11. Daily labor	
12. selling livestock	
13. If other specify	

Thank you!

Annex 10: Checklist Questions for Focus Group Discussion

1. Which kind of approaches used by the government to facilitating for the implementation of SWC? Which approached is preferable for farmers?
2. Which type of SWC are the most preferred technologies in your area?
3. How to evaluate agricultural extension service about soil and water conservation activities?
4. Why to farmers can't implementing SWC technologies?

5. How to understand benefits/effectiveness implemented of SWC technologies?
6. How to evaluate productivity of conserved and non conserved farm land?
7. What should be done to improve implementation of soil and water conservation?
8. How many months per year did the farmer face shortage of food and which month? Why?
9. What is the real situation of SWC adopter and non adopter food security status?
10. What type of coping strategies farmers used to recover for incase of food shortage?
11.

Annex 11: Checklist for key informant interview

1. What type of introduced SWC technologies and approaches implemented in the last ten years?
2. How do you evaluate SWC implementation approaches and farmers participating level?
3. Which technologies are preferable for many farmers? Why?
4. How do you evaluate level of soil erosion year to year?
5. What is the major cause of soil erosion?
6. How do you evaluate implemented SWC practices effectiveness?
7. How do you understand the use of SWC practices for productivity and livestock feed?
8. What are the factors that affect technology adoption status of farmers?
9. How many months per year did farmers face shortage of food and which month? Why?
10. What type of coping mechanisms farmers used in the case of food shortage?
11. Is there significant difference between SWC adopter and non adopter food security status?
12. What is your suggestion to improve SWC implementation?

Annex 12: Observational checklist

1. Physical Environment (Implemented SWC practices, slop, soil type etc.)
2. Infrastructures (Road, credit institute, light, drinking water supply, market, transport, health center access etc)

Annex 13:Secondary data collection format

1. Total size of woreda land ____________hectar.
   A. Cultivated land ___________
   B. Woodlot area_____________
   C. Grazing area_____________
   D. Bare land______________

2. Total Watershed coverage *Woreda* level-----------------hectare.
3. Soil type and major crop type
4. Farming system
5. Slop of the land
6. Rainfall amount
7. Main occupation
8. Food availability/sufficiency