College of Development Studies

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Factors Determining Adoption of Soil and Water Conservation Practice in Ankober District, North Shewa Zone, Amhara Region, Ethiopia

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DECLARATION

I Fetlework Belet, Registration Number GSR/3242/12, do hereby declare that this thesis is my original work and that it had not been submitted partially; or in full, by any other person for an award of degree in any other University.

Submitted by:

Full Name…….. Signature……..…… date……..

Approved by:

This thesis has been submitted for examination with my approval as University supervisor.

Name of Advisor ……...……. Signature …… date…….

APPROVAL

I undersigned certify that they have read and hereby recommend to Addis Ababa University to accept the thesis submitted by Fetlework Belet and entitled "Factors Determining the Adoption of Soil and Water Conservation Practice in Ankober District, North Shewa Zone, Amhara Region, Ethiopia," in partial fulfillment of the requirements for the award of a Master of Arts Degree in Development Studies (Environment and Sustainable Development)

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ACRONYMS

ADoFED	Ankober District Office of Finance and Economic Development
ANRS	Amhara National Regional State
BoFEC	Bureau of Finance and Economic Cooperation
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
SLM	Sustainable Land Management
SNNPR	Southern Nations Nationalities and Peoples Region
SWC	Soil and Water Conservation
SWCP	Soil and Water Conservation Practice
WOCAT	World Overview of Conservation Approaches and Technologies

ABSTRACT

Soil degradation is one of the most worrying environmental problem that compromising the very scarce natural resources without which crop production is not possible. The main purpose of this study was to identify the determinant factors affecting the adoption of soil and water conservation practice in Ankober district, Amhara National Regional State, Central Ethiopia. The study used a cross sectional survey design. Structured interview with 267 sample respondents were held, who were selected using probability sampling technique supplemented by key informant interview and focus group discussion. Descriptive statistics and binary logistic regression model were used to identify factors that determine the adoption of soil and water conservation practice in the study area. The result showed that 44.57% of the household heads adopted soil and water conservation practice. The resulting distribution further, show that (37.83%) and (30.71%) of the respondents in the study area adopted soil bund and stone bund types of soil and water conservation practice respectively followed by the check dam and cut of drain conservation practices, which accounts (17.98%) and (10.11%) of the respondents respectively. The rest of 3.37% of the respondents were adopted grass strip conservation practice. Variables such as educational status, access to extension service and non-farm income are significantly and positively affects the adoption of soil and water conservation practice in the study area. Whereas, land size and erosion perception of farmers significantly and negatively affects the adoption of soil and water conservation practice in the study area. Thus, in the process of soil and water conservation, these variables should be considered by the government decision makers, donor agencies at different level and individual farm household heads. For future studies, considering time serious data rather than depending on cross-sectional data is important to understand the observed differences.

Key Words: Adoption, Ankober, Logit Regression Model, Soil and Water Conservation

1. INTRODUCTION

1.1. Background

The pillar for the development of most developing countries depends on the performance of agricultural sector and the contribution of this sector depends on how the natural resources are managed. Unfortunately, the majority of developing nations, the quality and quantity of natural resources are degrading resulting in more severe droughts and floods (Mengistie, 2009). Soil erosion is the major causes of the land degradation, in fact soil erosion is a naturally occurring process, and however man-made activities that cause of land use changes are accelerating the erosion process that ultimately led to severe negative effects (Borrelli et al., 2017). It is well known that soil erosion causes severe loss of topsoil where organic matter and vital nutrients needed by crops, in order to survive, usually reside. This loss harms the farmland's suitability for farming and reduces its ability to retain water (Wall et al., 2003). Conservation of soil and water resources is the most important intervention to reduce the problem and thereby sustaining the environment and ensuring long lasting development as land and water are the most important natural resources for the survival of life and socio-economic development depend on (Sharma et.al, 2014).

Ethiopia is one of the largest countries in Africa both in terms of land area and population, where its economy mainly based on agriculture, which provides employment for 85 percent of the labor force, accounts for a little over 50% of the GDP and about 90 percent of export revenue. However, the agriculture is characterized by low productivity that challenged the sector in attaining food security at household level and self-sufficiency at a national level (World Bank, 2003). Of the different drivers, soil erosion induced land degradation is among top factors resulting low agricultural production and productivity. In the effort to reverse this problem government of Ethiopia has been formulating and implementing various policy and strategic measures on natural resources management. Promotion and implementation of soil and water conservation practices on farmlands and communal non-agricultural lands is among various efforts to enhance sustainable agricultural production and productively over the last four decades (Damene et al., 2013). Although, the soil and water conservation interventions lasted longer period adoption still remained an issue. In this regard, literatures confirmed that adoption of soil

and water conservation is still minimal. This implies that if the problem is not solved, it is difficult to sustain the environment and maximize the agricultural productivity. Therefore, this study was aimed to put in to the presented literatures on influencing factors affecting the adoption of soil and water conservation practice in Ankober District, Amhara National Regional State, Ethiopia.

1.2. Statement of the problem

Soil and water degradation are the most important and an ominous threat to the food security and development prospects of developing countries. Unfortunately, a huge tone of soil is eroded each year in most of the rural areas. The problem of soil and water depletion exists in most of the rural areas though the magnitude is higher in rural areas where agricultural activities are extensively practiced (Wall *et al.*, 2003).

Soil degradation is the most thoughtful environmental problems and it is a scarce natural resource without which crop production is not possible. Soil erosion may cause severe loss of topsoil where organic matter and vital nutrients needed by crops. This loss harms the farmland's suitability for farming and reduces its ability to retain water.

The soil and water conservation measures are limited by insufficient expertise, funding and adoption problems. Physical conservation measures believed as effective in controlling runoff, but most farmers are not interested in adopting the techniques because of its labor intensive that have high labor requirements and often do little to increase production or incomes over short period. Similarly, deforestation, poor agricultural practices, overgrazing and shifting cultivation are exacerbated by the increasing population that causing land degradation particularly in the upland areas. Although, farmers often recognize that erosion caused by wind or water is occurring on their land they do have limited knowledge on what to do about it. Consequently, control of land degradation and soil erosion in agricultural areas is not a high priority in most communities (FAO, 2016).

Like other developing countries, soil degradation is the most thoughtful environmental problems in Ethiopia. Particularly, the Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile lands and other factors attributed to population pressure (Tadesse and Belay, 2004). Although government has been

promoting massive soil and water conservation, the adoption of the practices among farming community remained challenge. In relation to this study revealed that different variables affect the adoption of soil and water conservation practice at household level. For example, Ashoori et al., (2014) showed that age, education, non-agricultural income, production cost, yield and distance from the home significantly affects the adoption of soil and water conservation practice. Likewise, Daniel and Mulugeta (2017) in their finding confirmed that sex, access to extension and training significantly affected adoption of the practice. Furthermore, Belachew et al., (2020) suggest that household size, livestock holding, land size, access to credit are significant factors to adopt the soil and water conservation practice.

However, there are inconsistencies in variable between different studies and in its significance as well. There are also differences among different study areas in agro-ecology and climatic zone; different studies also use different data analysis method and models. For examples Ashoori et al., 2014, Belachew et al., 2020, Daniel and Mulugeta (2017) studies used different variables, agro ecology, methods and time variation.

This gap initiates this study to fill the existed variation among studies and to fill the gap with the application of binary logistic regression model. Thus, this study was aimed to identify the factors that determine the adoption of soil and water conservation practice at household level in Ankober District, North Shewa Zone, Amhara National Regional State, Ethiopia to contribute to the existing limited literature.

1.3. Objective of the study

1.3.1. General Objective

The general objective of this study was to identify factors determining adoption of soil and water conservation practice in Ankober District, North Shewa Zone of Amhara National Regional State, Ethiopia.

1.3.2. Specific Objectives

- To identify soil and water conservation practices implemented in the study area
- To assess the adoption level of soil and water conservation practice in the study area

- To identify factors determining the adoption of soil and water conservation practice in Ankober District.

1.4. Basic Research Questions

- What is the adoption level of soil and water conservation practice in Ankober District?
- What are the soil and water conservation practices implemented in the study area?
- What are the factors that determine the adoption of soil and water conservation practice in the study area?

1.5. Significance of the Study

The determination of factors influencing decision on practicing soil and water conservation was essential in taking measures to alleviate the constraints affecting adoption of soil and water conservation structures. Identification of factors that affect the adoption of technologies can enhance the formulation and the implementation of the technology dissemination programs and policies. Thus, this work would play its own role for researchers and extension specialists to utilize the results of this study in modifying research and extension activities. Furthermore, the finding of this study was used by the government decision makers and stakeholders of the agriculture and environmental protection sector.

1.6. Scope and Limitations of the study

The study was made to have spatial and thematic delimitation. Spatially, the study was conducted in Ankober District of Amhara National Regional State, Ethiopia. The primary focus of this research was on the physical soil and water conservation practice in rural part. Thematically, the study was delimited to examine the level of practice of soil and water conservation and to identify factors that determine soil and water conservation practice in rural context.

2. LITREATURE REVIEW

2.1. Theoretical Literature

2.1.1. Operational Definition

Adoption: In this study adoption of soil and water conservation measures: means accepting and implementing improved soil and water conservation technologies by the households.

Adopter: means a household head who accepts and put into practices a given soil and water conservation structure and sustain it on his farm land.

Non-adopter: means, those household heads who take not to practice soil and water conservation structures on their farm land.

2.1.2. History of soil and water conservation practice in Ethiopia

Soil and water conservation initiatives in Ethiopia began in the mid-1970s, soon after the drought of 1973-1974. The most well-known SWC intervention is the Food-For-Work (FFW) programme, which lasted 15 years from 1980 to 1994. The FFW project was converted into the LLPPA (Local Level Participatory Planning Approach) and, later, the Managing Environmental Change (MEC) .Resources to Enable Transitions (MERET) is a programme that aims to make transitions easier(MERET 2013; Nedassa et al. 2011).

2.1.3. The concept of soil and water conservation practice

Soil and water conservation are important in reducing and restoring land degradation; protecting infrastructure from sediment damage; and managing water effectively in rain fed systems at both field and watershed scales. The emphasis should be on working across catchments to slow the movement of water through the landscape, to enhance infiltration and availability of water and reduce erosion. Low-cost water conservation practices in rain fed uplands are important to improve crop yields and to reduce production risks and droughts (FAO, 2016).

Terms for soil and water conservation technologies and approaches are not consistently used and mean different things to different people and even to the same people at different times (Liniger

et al, 2002). In fact, no globally approved system exists. Some given names refer to the appearance such as terraces, bunds ditches. Some combine the appearance with the materials used e.g., stonewalls, earth bunds, grass strips, some add the slope or drainage e.g., graded ditches. Some refer to the land management such as enclosure, others to the way of construction, such as Fanya juu (a swahili term describing the way soil is thrown upwards to build the bund) to the function and impact.

The World Overview of Conservation Approaches and Technologies (WOCAT) were started in the 1990s as a global initiative in order to support better management of SWC knowledge. The WOCAT Classification of SWC Technologies categorization was developed and reflects an intense participatory development process. Agronomic, vegetative and structural combinations are possible. Each of these conservation categories is split up into subcategories. The main criteria are the appearance, the materials and the management involved in the technology. The proposed system works mainly on the principle of the appearance, the materials and the management involved in the technology. The function e.g., how they manage the water (control splash, control dispersed and concentrated runoff, improve infiltration or improve the fertility, their impact on the outputs and others) should be assessed for each of the technologies separately (Liniger et al., 2004; Liniger and Schwilch, 2002).

2.1.4. Types of soil and water conservation practice implemented in Ethiopia

The most common soil and water conservation practice implemented in Ethiopia are soil bund, Hillside terrace, Stone check dam, Stone bund, Diversion ditch, Brushwood check dam, Stone faced soil bund, Stone faced trench, Gabion check dam, Double stone faced soil bund, Micro-basin, Sediment storage dam, Fanya juu terrace, Bench terrace, Live check dam, Tied ridges, Semi-circular terrace Stone, Check dam, Bench terrace, Eyebrow basin, Gully reshaping and planting, Zai pit, Deep trench Sand/soil filled check dam, Trash line, Terrace and trench and Cut-off drains(Adimassu et al. 2017).

2.2. Empirical Literature

2.2.1. Adoption of Soil and Water Conservation Practice in a Global Context

Barman, and Das, (2010) conducted a study and their finding show that physical characteristics of the farm i.e., number of livestock reared, fragmentation of plots and slope of land all demonstrated expected signs but only the coefficient of slope is found to be significant. From the results it can be concluded that the data support the hypotheses formulated about the relationships of these variables with conservation efforts. The hypothesis that the younger farmers spend more time and energy in soil and water conservation measures is based on the fact that the younger farmers possess higher level of education and are more concerned about the problems of soil erosion and water degradation.

Ashoori et al, (2015) conducted a research entitled an examination of soil and water conservation practices in the paddy fields of Guilan province, Iran using descriptive and analytical statistics. The findings indicated that the mean levels of SWC practices vary considerably at the 0.01 level of significance by groups of age, education, non-agricultural income, production costs, yield, cultivated paddies and distance from home to the farm or to the main road. Similarly, significant differences were observed by groups of family size, rice production, ownership of livestock and profits from rice production at 0.05 level. The levels of experience in agriculture and ownership of poultry were found to have no significant effects on SWC practices.

Keshavarz et al., (2017) undertake an empirical analysis on factors on farmer’s adaptation behavior in water scarcity conditions in rural communities. Their findings indicate that there is a significant relationship between awareness and adaptation behavior. Meanwhile, there is a significant relationship among network and media on farmer's perception about water scarcity and their activities toward better management of water in the critical condition. There are also significant relationships among perception and awareness with intention however, intention do not affect adaptation behavior strongly. In other words, even the means farmers had information about crisis, they are not able to have not operational plans to confront the water scarcity conditions.

2.2.2. Factors Affecting Adoption of Soil and Water Conservation in Africa

Huckett P., (2010) conducted a comparative study on factors affecting adoption of soil and water conservation practices among small hold farmers in the Njoro River Watershed of Kenya. Adoption rates for SWCPs were expected to be low (less than 20%). Increased formal education, income, access to information, and security of land tenure and soil characteristics, were expected to positively influence adoption. For data analysis the study included descriptive statistics and use of classification and regression trees. The results indicated that all sampled farms had adopted the favored practices that were easier to implement and more effective for resource protection and food production. Years in residence and income emerged as primary explanatory variables for adoption of SWCPs, while soil quality and formal education were secondary. Only 27% of surveyed farmers held title deeds, but the others perceived that land occupation conferred ownership and hence implemented SWCPs.

Belachew et al., (2020) studied factors that influencing the adoption of soil and water conservation practices in the northwest Ethiopian highlands. The results revealed that the likelihood of decisions to adopt soil bund, stone bund, check dam and strip cropping were 74, 56, 29 and 56% respectively. The joint probability of adopting the selected soil and water conservation practices was 14.2%. The model results also confirmed that age, sex, education level, household size, livestock holding, land size, access to credit, access to extension service and training were significant factors that affected the adoption of soil and water conservation practices in the study area.

Asfaw and Neka (2017) analyzed factors affecting adoption of soil and water conservation practices, the case of Wereilu District, Amhara Region, Ethiopia. The analysis result showed that sex of household heads, education status of household heads, access to extension services and training were positively correlated at significantly level with the adoption of the introduced soil and water conservation practices. On other case, the age of household heads, off-farm activity, and distance of farmlands from homesteads influenced the adoption of introduced soil and water conservation practices negatively. The finding depicts that the identified physical, socioeconomic, and institutional factors influence the adoption of soil and water conservation

Tadesse and Belay (2004) studied factors that determine adoption of physical soil conservation measures, namely soil bunds and fanyajuu in Southern Ethiopia. Data collected from a random sample of 120 heads of households were used to estimate the binomial logit model. The results show that adoption of soil conservation measures depends on a host of factors.

Gebeyanesh et al., (2017) in their study that focused on factors which affect the decision of farmers to adopt soil and water conservation practices in their local conditions. Majority of the farmers have awareness about the introduced soil and water conservation and few of them implements it. The rest uses cultural practices such as diversion ditch and water ways. Nonetheless, the sustainability of the implemented structures was unlikely. The study concluded that many of those problems were related lack of real participation of farmers in planning of conservation effort.

Zenebe et al., (2013) on their study paper presents the findings that evaluated farmers' preferences of SWC practices, including the economic perspective; as a basis for enhancing adoption of the technologies in the central highlands of Ethiopia. Four soil and water conservation (SWC) practices; soil bunds alone, soil bunds with vetiver grass, soil bunds with Susbania susban and soil bunds with elephant grass, were evaluated in the Borodo Watershed in the central highlands of Ethiopia. These are the only SWC measures introduced and implemented in Borodo watershed. Data on these SWC practices were collected from farmers using focus group discussion. A multi-criteria analysis approach was used to analyses the data. The criteria were weighted using pair-wise ranking and SWC practices were scored with a scale of to five based on each criterion. Farmers assigned highest relative weights to criteria related to economic criteria than technical and stability criteria.

Dilebo T., (2017) conducted a study on the determinants of adoption of soil and water conservation practices at household level in Aletawendo District, Sidama, Ethiopia. The study result indicated that seven variables were affecting adoption decision of farmers significantly and positively. These were education level of the household head, training participation, and total income, perception of farmers for soil and water conservations, preference of farmers, extension contact, and land ownership certificate.

Birhan B., (2009) studied factors affecting the adoption of soil and water conservation practices in north eastern Ethiopia a case of Meket Woreda. The result of the model shows that the explanatory variables: farmers' level of perception on soil erosion, farmers experience in extension service given by development agents increases the likelihood of adoption of soil and water conservation practices measures by the farmers. On the other hand, involvement in off farm activities has a negative and significant influence on the adoption of soil and water conservation activities in the study area.

2.3. Conceptual Framework

From both the theoretical and empirical literature discussed in the aforementioned paragraphs, we have seen that adoption of soil and water conservation practice is influenced by a multitude of factors that can reasonably grouped into demographic, socio-economic and other factors need to understand. To align the conceptual framework with the research objectives, adoption of soil and water conservation practice was the dependent variable and the mentioned independent variables. The conceptual frame work for this study showed in the following figure.

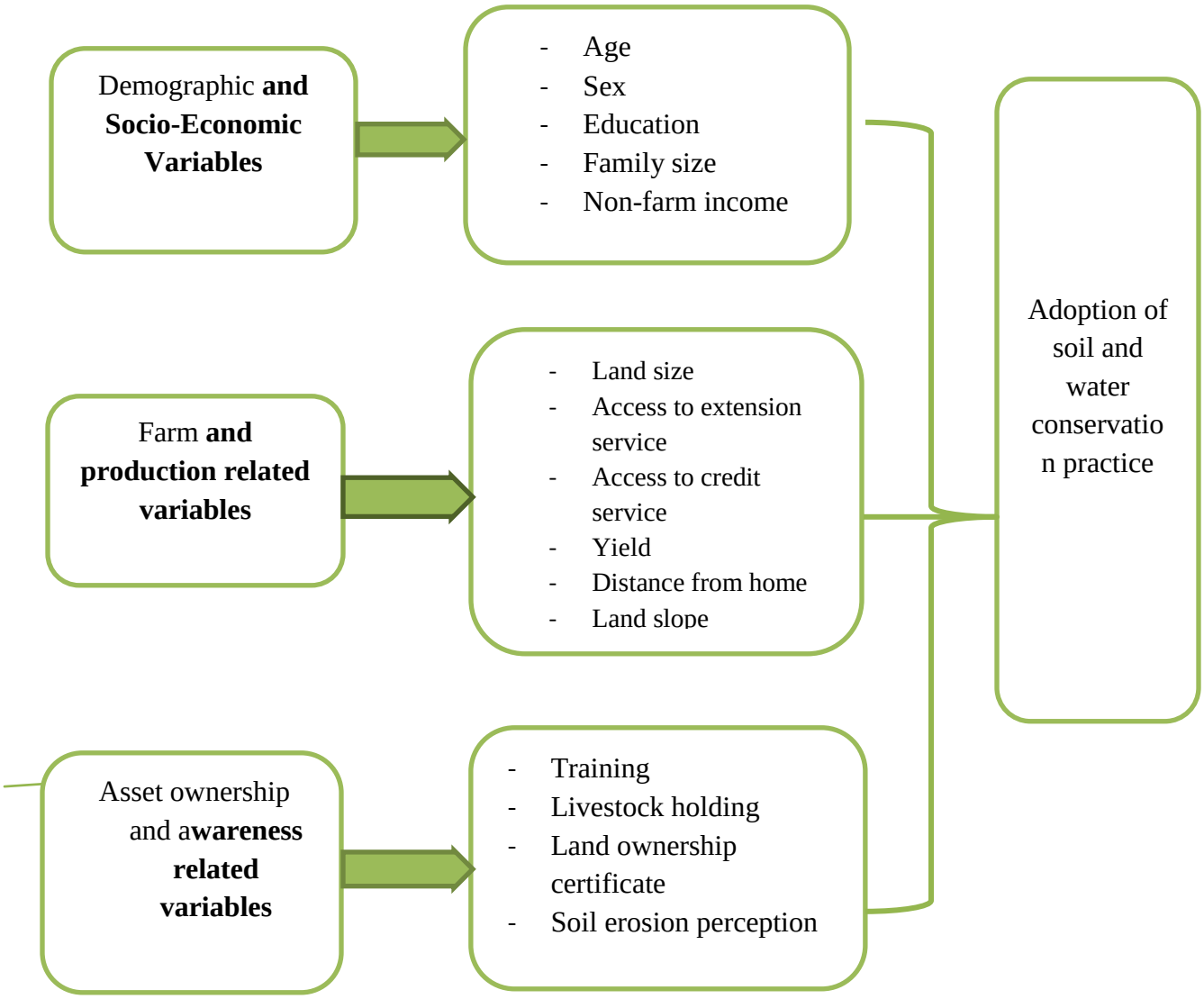

Figure: 2-1. Conceptual Framework Developed by the Researcher, 2021

3. MATERIALS AND METHODS

3.1. Description of the Study Area

Ankober District is located in the eastern escarpment of the Ethiopian highlands and situated 172 km north of Addis Ababa and 42 km to the east of Debre Birhan, the capital of North Shewa Zone. In geographic term the district is located between 9°22′ to 9°45′ N and 39°40′ to 39°53′ E totally covering 79,558 hectares (ADoFEC, 2020). The district has a total population of 94,463 (48,925 men and 45,538 women) of whom only 6272 (7.5%) are urban inhabitants (ADoFEC, 2020).

According to ADoFEC (2020) the agro-ecologically of the district varying from Kolla to Woina Dega with average temperatures is 16.95°C with a mean maximum value of and a mean minimum value of 27.2°C and 6.6°C. The mean annual rainfall of the area is 1100 mm that falling in two wet seasons, from February to March (Spring season) and July to September (main rainy season) which traditionally called Kiremt season.

The major source of the livelihood in the district population is mixed farming (crop and livestock production). Petty trading, wage labor, fire wood and charcoal selling are also among the other livelihood strategies of the people in Ankober district (Ankober District, 2020).

According to FAO/UNDP (1984) in the district are of volcanic origin. Black and reddish-brown soil types are mentioned as the dominant soil forms in Ankober District. The two principal soil types are black and compact clays (Black soil) and reddish-brown heavy loams (Red soil), originating from the disintegration of volcanic substrates, are known to form the central plateau of Ethiopia. Red and Brown soils and loams are the most common soils in the highlands, making up over 60% of plateau soils, and are also the most common forest soils.

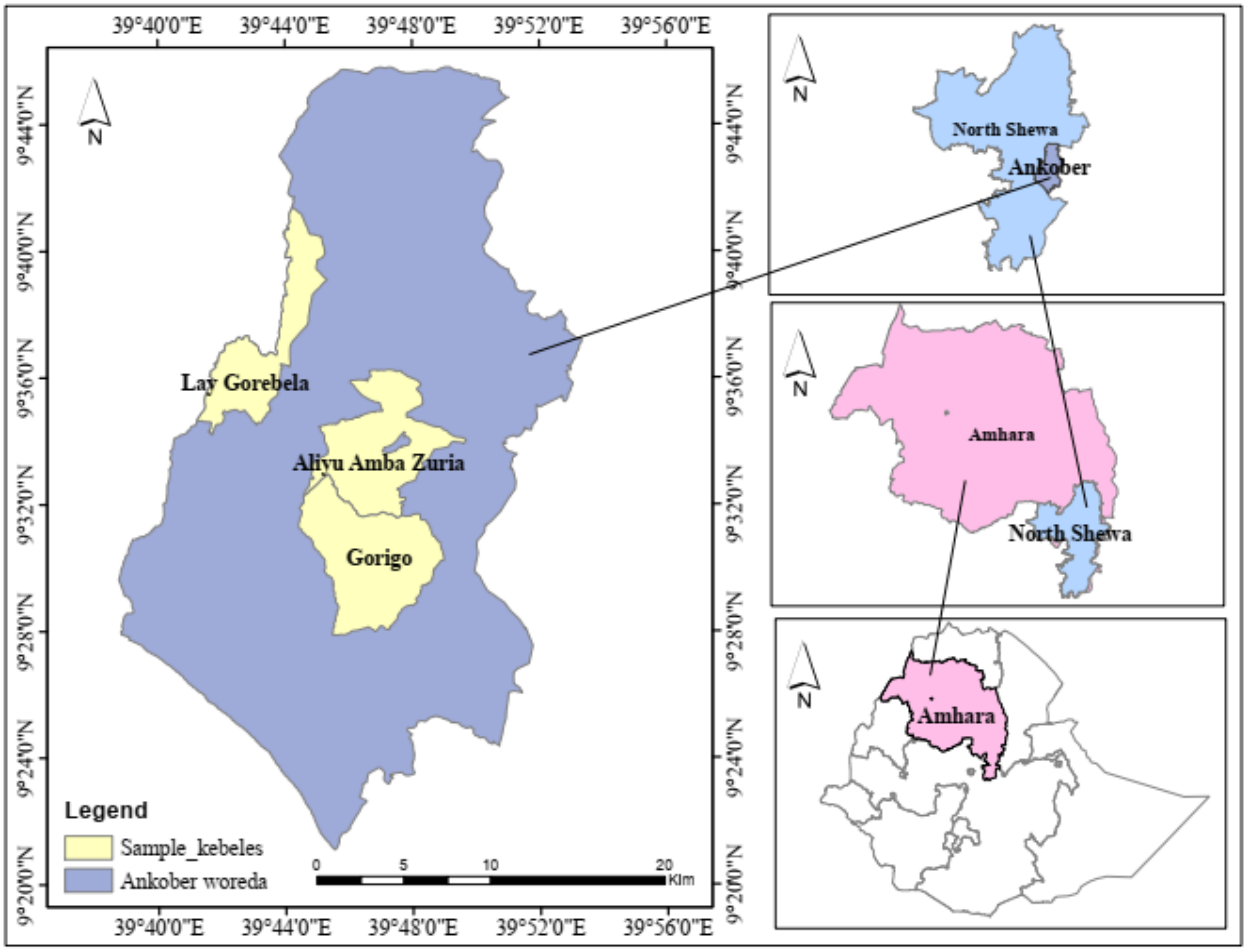

Figure 3-1 Map of the Study Area (own prepared)

Ankober district is divided in to 19 rural grass root level administrative units known locally by the name "*kebele*" which is the lowest administrative unit in Ethiopia. Agriculture is the dominant economic activity which is the basic livelihood of the majority of residents of the study area. The agricultural activities are characterized by mixed farming system in which both crop and livestock production carried out simultaneously. The most important crops produced in the district are cereal crops that including teff, maize, barley, wheat and other legume crops are predominant. In the study area different soil and water conservation structures are practiced. Among these bench terrace, hill side terrace, soil faced stone bund, soil moisture structures (micro trench and percolation trench) are predominantly practiced in the study area (Ankober District, 2020).

3.2. Research Design

This study was used a survey research method since it is based on households' survey as a unit of analysis. Therefore, a cross sectional survey research method was conducted to identify factors determining adoption of soil and water conservation practice in Ankober district, North Shewa Zone, Amhara National Regional State.

3.2.1. Study Population and Sampling Frame

The study area, Ankober District, was selected purposively among 22 rural districts in North Shewa Zone, because I know the area well. According to ADoFEC (2020) the district is divided by 19 rural administrative "kebeles" which has 14,730 households. Households are the smallest sampling units for this study and the heads of each household was served as a target study population. The district is characterized by three agro-ecological zones (Dega 12%, Woyna dega 51% and Kolla 37%). Thus, the three agro-ecological zones formed the base for three different clusters of "kebeles." Because, except agro-ecology differences, all rural kebeles of the district has almost similar characteristics in socio-economic and cultural practices. Out of these, one kebele from each agro-ecology cluster (Laygorobela from Dega, Gorgo from Woynadega and Alayuamba from kola) was selected randomly through lottery system, considering the time and cost limitations. Thus, three kebeles selected randomly from each cluster have a total of 2,950 household heads which was used as sampling population.

3.2.2. Sample Size Determination and Sampling Techniques

Both probability and non-probability sampling techniques were used to determine the survey households in this study. From the sampling population of 2950 household heads formed the sample frame. Thus, the sample respondents were determined based on Yamane (1967) simplified formula (Eq.1). To calculate sample sizes assuming a 95% confidence interval and P = 0.05 level as shown below.

$$n = \frac{\mathrm{N}}{1+\mathrm{N(e)2}} \quad \text{Eq. 1}$$

$$\mathrm{n} = \frac{2950}{1 + 2950(0.05)2} = 352$$

Where ´´n´´ is the sample size, ´´N´´ indicates the size of population, and ´´e´´ is the level of accuracy.

Since, the target population is less than 10,000 the desired sample size is adjusted using finite population correction formula. Because a given sample size provides proportionately more information for a small population. Thus, the sample size is adjusted as follows

$$fn = \frac{n}{1+\frac{n-1}{N}} \qquad \text{Eq.2}$$

$$fn = \frac{352}{1+\frac{352-1}{2950}} = 267$$

Where: N= the target population size, which is 2950

fn = The adjusted sample size

n = the sample size which is 352

Therefore, based on Yamane (1967) simplified sample size determination formula the sample size of the study was made to be 267 household heads.

According to Bhattacherje (2012) systematic sampling technique involves a random start and then proceeds with the selection of every k^{th} household head from that starting point onwards (k = N/n), where k is the ratio of sampling frame size ´´N´´ and desired sample size ´´n´´. Hence, this study was used this method to select every 8^{th} household head from "kebele" name list in three "kebeles" until the total sample size of the study reached.

Furthermore, key informants and focus group discussion participants were selected from Ankober district Agricultural office and other concerned data sources as well as North Shewa Zone Agriculture Department having deep information about the issues as a result of their official responsibility and professional role.

3.3. Data Source and Instruments

The study was used both primary and secondary data sources using different data collection instruments that enabled to achieve the objectives of the study. The primary data was collected from sample household heads, FGD and key informants in the study area of Ankober District. The study was used data collection instruments such as: structured questionnaires, key informant interview guidelines and focus group discussion.

3.3.1. Structured Interview Questionnaire

Structured interview questionnaire was prepared and translated to Amharic which is the local language in the study area. This technique was used to collect cross sectional data from primary sources which are administered by university degree graduates in the district who take research course under close supervision of the researcher. The interviewers were well oriented by the researcher and familiarized on the interview process, purpose of the study and how to approach the respondents ethically to generate consistent data.

3.3.2. Key Informant Interview

The key Informant Interview was held with Zonal and District level Agricultural development Department/Office natural resource protection experts, coordinators, team leaders and the heads of the office at district and zonal level. The local level agriculture development office head and extension workers were also be part of the key informant interview.

3.3.3. Focus Group Discussion

Focus Group Discussion was also used to generate primary data from the grassroots level communities. The focus group discussion was held with the women, youth and well-known persons who know the area natural resource for a relatively long period of time. This enabled the researcher to get qualitative data to explain the adoption of soil and water conservation practice.

Secondary sources of data were also other source to collect data from published and unpublished materials. Manuals, journals, sectorial reports, previous researches, websites and regulations in relation with this study were reviewed well.

3.4. Methods of Data Analysis

The collected data was analyzed by using both qualitative and quantitative methods. The qualitative data from the FGD and key informant interview was transcribed and systematically analyzed using qualitative data analysis techniques which was used to justify and elaborate quantitative data analysis results. This was presented in the form of narrations and statements to support the findings of the study. On the other hand, the statistical analysis was taken a form of descriptive and inferential statistics. The descriptive statistics was presented as frequency, percentage, tables, mean and standard deviation to describe the socio-economic characteristics of respondents.

The inferential statistics was used to identify factors that affect adoption of soil and water conservation practice. Binary logistic regression was employed to estimate the level of determination of demographic and socio-economic variables on the dependent variable. Then the collected data was entered, cleaned and analyzed using STATA data analysis tool.

3.5. Model Specification

The dependent variable in this study is adoption of soil and water conservation practice which was measured as a binary outcome. Adoption of soil and water conservation practice is a binary variable, best measured in terms of adoption of soil and water conservation practice by the households. In this study to investigate the factors influencing the adoption of soil and water conservation practice, binary logistic regression was used. This model is a statistical technique for predicting probability of an event, given a set of predictor variables.

Logistic regression was used to predict the propensity of adoption of soil and water conservation practice on the basis of independent variables and to determine the effect size of the independent variables on the dependent and to understand the magnitude of the effect of predictor variables. The impact of predictor variables is usually explained in terms of odds ratio and hence the name logistic regression, also called the log-odds function. This model applies maximum likelihood estimation after transforming the dependent into a logit variable (the natural log of the odds of the dependent variable occurs or does not occur). Binary logistic regression is one part of logistic

regression which is predictive model that can be used when the outcome variable is categorical variable with two choices and the independent variables are of any type.

Binary logistic regression has other application of combining the dependent variables to estimate the probability that particular event will occur, that is a subject which was a member of one of the groups defined by the dichotomous dependent variable. Due to the above-mentioned issues, the binary logistic model of adoption of soil and water conservation structure in this study was specified as follows (Eq.3):

$$P_i = \frac{e^{\beta_o+\beta_1 X_1+\cdots+\beta_k X_k}}{1+e^{\beta_o+\beta_1 X_1+\cdots+\beta_k X_k}} = \frac{e^{X'\beta}}{1+e^{X'\beta}} \quad \text{Eq.3}$$

Where, P_i = is the probability of adoption

Hence, the logit transformation of P_i given as follows (Eq.4):

$$logit(P_i) = log\left(\frac{P_i}{1-P_i}\right) = \beta_o + \beta_1 X_1 + \cdots + \beta_k X_k \quad \text{Eq.4}$$

Where

P_i: is the probability of adoption

β_0: *is the intercept term*

β_i: *is the coefficient of xi*

X_i: *are the explanatory variables*

A logistic regression model used to determine the relationship between a binary outcome dependent variable and a group of predictor variables. More formally, let **y** be the binary outcome variable indicating adopter/non adopter with 1/0 and p be the probability of y to be 1,

$$P = prob\,(y = 1).$$

Let x1... x10 be a set of predictor variables. Then the logistic regression of y on x1... x14 estimates parameter values for β0, β1. . . β14 via maximum likelihood method of the following equation (Eq.5).

$$logit(p) = \log(p/(1-p)) = B_{0+}\ B_1 * X_1\ + \cdots + B_{10} * X_{10} \quad \text{Eq.5}$$

Given the above stated model of binary logistics, the likelihood of the farmers to adopt SWC is given by the expression $p_i = \frac{1}{1-e^{-z_i}}$ where $z_i = \beta_1\ + \beta_2 X_i$while the probability of not adopting SWC is given as $1 - p_i = \frac{1}{1+e^{z_i}}$. Hence, the log of the odds ratio is the natural log of the two probabilities i.e. $(\frac{p_i}{1-p_i})$ as defined by Gujarati, (2004).

The independent variables in this study were identified based on the existing empirical literatures and actual conditions in the study area which are useful to explain the dependent variable.

Table 3.1: Variable Definition, Measurement and Expected Signs

Variables	**Definition of variables**	**Measurement**	**Expect. Sign**
Dependent Variable			
Adoption of SWC practice	1 if the household head adopts SWC structures, 0 otherwise	Dichotomous	
Independent Variables			
Age	Age of the respondent in years	Continuous	+
Sex	Sex of the household head	Dummy	+
Education level	Year of schooling	Categorical	+
Family size	Number of family members in the household	Continuous	+
Non-farm income	Income from non-agricultural activities	Categorical	-
Land size	The amount of land size in hectare	Continuous	-
Access to extension	Access to agriculture extension service	Categorical	+
Access to credit	Household heads access to credit from financial institutions	Categorical	+
Soil erosion perception	Households perception on soil erosion	Categorical	+
Yield	The amount of yield earned per year	Continuous	-

Distance from home	Distance between home and farm land	Continuous	-
Training	Access to agriculture related trainings	Categorical	+
Livestock holding	Household heads livestock ownership	Categorical	-
Land certificate	Household heads land use certificate	Categorical	+
Land slope	Sloppiness of the land position	Categorical	+

Source: Derived from literature review, 2021

3.6. Reliability and Validity of the Instruments

The reliability of the questionnaires used in the study was assured through critical and successive review of this instrument for data collection by academicians where relevant changes and additions were made where necessary. On the other hand, to assure validity, questionnaires were designed on the basis of previous studies' questionnaires and review of related literatures and objective realities of the study area. Furthermore, to make the instruments even more suited to the rural household in the study area. In addition, a pilot test was conducted by some sample questioners to refine the methodology before administering the final data collection. The structured questionnaires were tested on potential respondents to make the data collecting instruments objective, relevant, suitable to the problem and reliable.

3.7. Ethical Considerations

The study tried to keep the data collection effort in line with ethically acceptable guideline. First, the researcher got a written consent of the concerned agriculture institution. Added to this, all participants included in the study were duly informed about the purpose of the study and their willingness was secured before filling up the questionnaire and conducting focus group discussions. The study also maintained the confidentiality of the identity of each participant.

4. RESULT AND DISCUSSION

4.1. Results of descriptive statistics

4.1.1. Demographic and socio-economic characteristics

The study surveyed a total of 267 sample respondents through interview questionnaires which makes the response rate for the study to be 100% without default from the expected sample size. The results presented in this study are based on this number of sample respondents from the study area. Looking first to the age of respondents as shown in Table 4.1., the average age was 38.7 years with standard deviation of 10.0 from the mean age of the respondents. The analysis result indicated that most of the respondents of the study were adults given the mean value of age with its average variation. When the age variation is considered the respondents have a huge difference in their age where the minimum age was 26 years while the maximum respondent 78. The wide gap in age between sampled respondents enables to better understand the adoption of SWC practice among households.

Table 4.1. Distribution of respondent's age and family size

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	267	38.71536	10.03909	26	78
FamSize	267	3.041199	0.974384	2	6

Source: 2021 field survey

Results from descriptive statistics in Table 4.1 indicate that, the average family size of respondents was 3 members with standard deviation of 0.97 from the mean family size of the respondents. The result indicated that most of the respondents of the study have nuclear family given the mean value of family size with its average variation. When the family size variation is considered the respondents have a reasonable difference in their family size where the minimum family size was 2 members while the maximum respondent family size was 6 members.

Table 4.2. Distribution of respondents by sex and educational status

Variables	Freq.	Percent	Cum.
Sex			
Female	63	23.6	23.6
Male	204	76.4	100
Total	267	100	
Education			
No formal schooling	146	54.68	54.68
Grade 1-4	54	20.22	74.91
Grade 5-8	34	12.73	87.64
Grade 9-10	21	7.87	95.51
Grade 11-12	12	4.49	100
Total	267	100	

Source: 2021 field survey

The reasonable gap in family size between sampled respondents enables to better understand the adoption of soil and water conservation practice among households.

Table 4.2 provided gender of study participants, which indicates that the highest proportion in this study was contributed by male respondents which makes 76.4% of the total sample, while female respondents has a lesser contribution (23.6%). The resulting data from respondents also gives a clue that the majority of male household heads tend to concentrate on soil and water conservation practice.

Regarding the educational qualification of respondents of the study community as shown in, Table 4.2, the majority of participants (54.7%) have no formal schooling as a manifestation of how much as the household heads are less involved to adopt the SWC practice. The focus group discussion with the locality government experts also supported this argument that absent or low level of education is a hurdle to adopt the SWC practice. Also, great deals of respondents (20%) have attended first cycle school level education and only 4.5% respondents completed preparatory school.

4.2. Types of Implemented Soil and Water Conservation Practice

The classification of types of soil and water conservation practices into different types in the study area bases the regional natural resource conservation guideline and manuals for conservation practice and monitoring the soil and water conservation practices. The resulting distribution show that, (37.8%) and (30.7%) of the respondents in the study area were adopted soil bund and stone bund types of soil and water conservation practice respectively, which was followed by the check dam and cut of drain conservation practices, which accounts (18%) and (10.1%) of the respondents respectively. The rest of 3.4% of the respondents were adopted grass strip conservation practice.

Table 4.3. Distribution of types of soil and water conservation practice in the study area

Variable	Freq.	Percent
Type of SWCP		
soil bund	101	37.83
stone bund	82	30.71
check dam	48	17.98
cut of drain	27	10.11
grass strip	9	3.37
Total	267	100

Source: 2021 field survey

4.3. The Adoption Level of Soil and Water Conservation Practice

The descriptive result on the adoption level of soil and water conservation practice distribution of respondents is presented in table 4.4 as follows.

Table 4.4. The adoption of soil and water conservation practice characteristics

Variable	Freq.	Percent	Cum.
Level of adoption			
No	148	55.43	55.43
Yes	119	44.57	100
Total	267	100	

Source: 2021 field survey

The descriptive result in Table 4.4 on the adoption of soil and water conservation practice of the study participants indicates that (44.6%) of the respondents adopted soil and water conservation practice. On the other hand (55.4%) of the respondents are not adopters of the soil and water conservation practice. The resulting data from key informant interview and focus group discussion supports this finding of low status of adoption.

Table 4.5 provided farmers perception regarding on showed sustainability of the soil and water conservation practices on farmers land, the mean length of stay is 3.4 years with standard deviation of 1.859 from the mean length of stay of the respondents. The result indicated that most of the soil and water conservation practices that are implemented by the respondents have shorter periods of time, given the mean value of length of stay or sustainability with its average variation.

Table 4.5. Length of stay or sustainability of the SWC practice

Variable	Obs	Mean	Std. Dev.	Min	Max
Sustain_SWC	267	3.389513	1.859229	1	8

Source: 2021 field survey

According to the result in table 4.5 the length of stay or sustainability variation is considered the soil and water conservation practices adopted by the respondents have a reasonable difference in their length of stay where the minimum length of stay was 1 year while the maximum was 8 years. The wider gap in length of stay between sampled respondents enables to better understand the sustainability of SWC practices among households.

4.4. Farm and production related characteristics

The result on farm and production related characteristics of the respondents, as presented in table 4.6 shows that, a smaller amount of respondents are participating in non-farm income generating activities contributing about (33%) of the total sampled respondents while the majority of the proportion belongs to non-participants in non-farm income generating activities, which are (67%). This indicate that most households might not have very high competing interest on labor to engage on soil and water conservation practice

Table 4.6. Non-farm income, extension service and credit characteristics

Variables	Freq.	Percent	Cum.
Non-farm income			
No	179	67	67.04
Yes	88	33	100
Total	267	100	
Access to extension			
No	145	54.3	54.31
Yes	122	45.7	100
Total	267	100	
Access to credit			
No	157	58.8	58.8
Yes	110	41.2	100
Total	267	100	

Source: 2021 field survey

Table 4.6 shows that, on access to extension service of the study participants indicates that (45.7%) the respondents have access to extension service on soil and water conservation practice, while (54%) of the respondents have no access to extension service. The resulting data from respondents also gives a clue that the majority of household heads are not informed through extension service to adopt SWC practices.

Further, looking to the variable access to credit, (41.2%) of the respondents have access to credit service, whereas the vast majority of respondents contributing (58.8%) have no access to extension service. The result indicates that most of the respondents have no sufficient access to finance to engage in non-farm income generating activities which are believed to be supportive to soil and water conservation practices.

From table 4.7. Looking to the land size of respondents, the average land size was 0.95 hectares with standard deviation of 0.61 from the mean land size of the respondents. The result indicated that most of the respondents have less than a hectare of land given the mean value of its average variation. Considering the variation, respondents have a huge difference in their land size where the minimum land size was 0.2 hectare while the maximum respondents have 2 hectares of land. The gap in land size between sampled respondents enables to better understand the adoption trends of soil and water conservation among households.

Table 4.7. Land size and distance from farm land

Variable	Obs	Mean	Std. Dev.	Min	Max
LandSize	267	0.954045	0.61689	0.2	2
Distance	267	1.416479	0.72999	0.2	3

Source: 2021 field survey

Further, the result on distance of respondents from their home to land shows that, the average distance was 1.41 kilometer with standard deviation of 0.72 from the mean distance of the respondents. The result indicated that most of the respondents have a reasonable distance from their land given the mean value of its average variation. The minimum distance was 0.2 kilometer while the maximum distance was 3 kilometers from home. The gap in distance between sampled respondents enables to indicate the adoption of soil and water conservation practices among households.

The land use characteristics of respondents presented in Table 4.8 shows that the majority of participants were using their land for ploughing (66.3) and grazing (22.1%) purpose, which is a clear manifestation of rural agricultural economic society in rural Ethiopia. In fact very few (2.62%) respondents use their land for forestry purpose, mainly as woodlot. In relation to this FGD participants indicated that few farmers plant tree on woodlots for income generation

purpose. This result clearly indicates the poor attention of household heads to forestry may be because of land scarcity. The KII with the government officials also supported this argument that they pay due attention for rural economic diversification.

Table 4.8. Land use characteristics of respondents

Variable	Freq.	Percent	Cum.
Land Use			
Ploughing	177	66.29	66.29
Grazing	59	22.1	88.39
Forestry	7	2.62	91.01
Residence	15	5.62	96.63
Other	9	3.37	100
Total	267	100	

Source: 2021 field survey

Figure 4.1 shows the farmers perception on sloppiness of their farmlands, accordingly nearly half respondents (47%) agreed that their farmlands have steep slope, while (28%), disagreed that the their farmlands don't have such problem to perform agricultural activity. On the other hand, the strongly disagree and strongly agree category of respondents about sloppiness of their farmland for agricultural activities accounts for about (4.1%) and (8%), respectively. From this it can be inferred that somehow greater than half (56%) proportion of survey households acknowledged considered steepness of their farmlands and thus they might consider SWC practices to reduce the effect of slope.

Furthermore, Figure 4.1 shows the farmers perception on sloppiness of the land in this study.

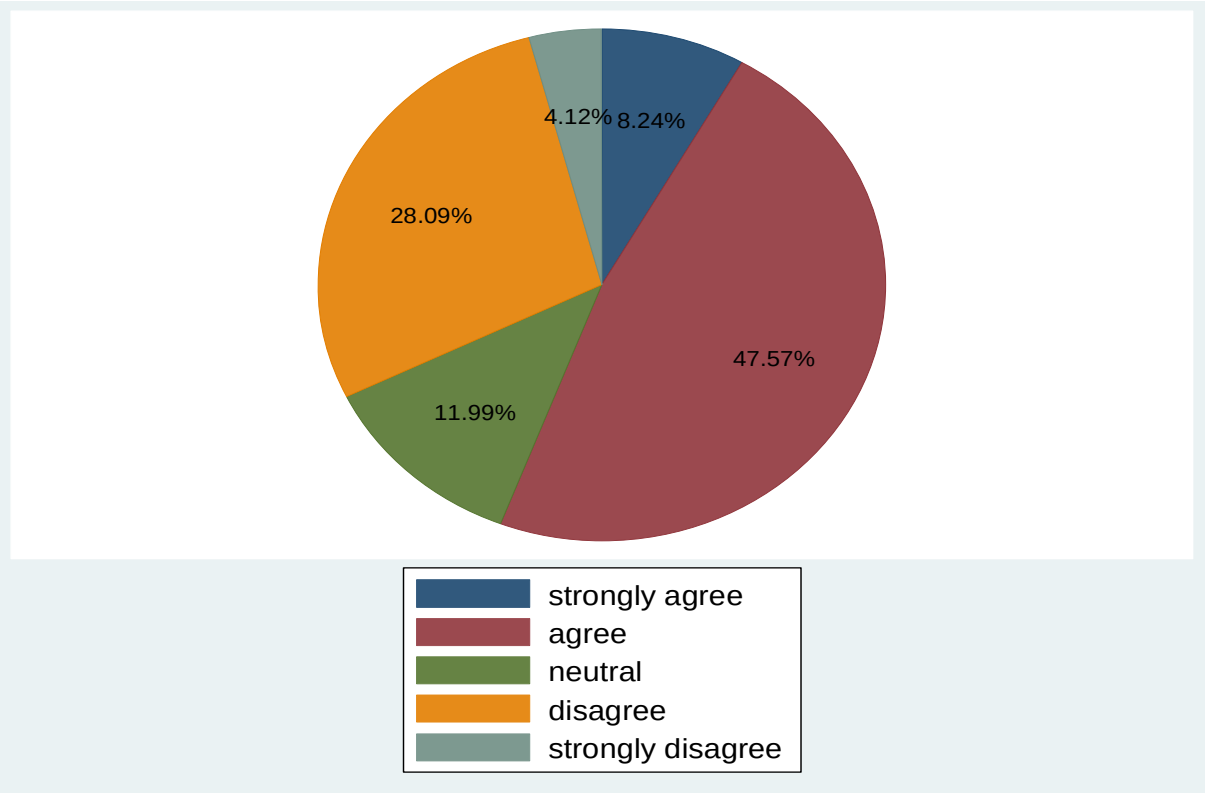

Figure 4-1 Land sloppiness perception category of participants computed from STATA

Moreover, the descriptive statistics result, regarding the yield productivity perception of respondents in the study area, Table 4.9 shows that the majority of respondents, which accounts (37%) perceived as their land has poor yield productivity. This finding was also supported by the key informants in whom they believed that their land productivity per hectare is declining through time to time.

In connection to this, about 61.8% respondents evaluated their farmland as it have poor (37.5%) and very poor (24.3%) productivity, while the remaining 35.6%, 1.9% and <1% respondents evaluated their farmlands as it have good, optimal (moderate) and very good productivity, respectively (Table 4.9).

Table 4.9. The land yield productivity perception of respondents

Perception			
Yield productivity perception	Freq.	Percent	Cum.
very good	2	0.75	0.75
Good	95	35.58	36.33
Neutral	5	1.87	38.2
Poor	100	37.45	75.66
very poor	65	24.34	100
Total	267	100	

Source: 2021 field survey

The result is a complete manifestation of how much the land is becoming degraded and less productive. The focus group discussion was also supported this argument that productivity of the land is becoming low and low from year to year both in quantity and quality. Also, a great deal of respondents (35%) of the total, respond that their yield productivity is good.

4.5. Survey households asset ownership and awareness characteristics

The other respondent's characteristics considered in this study include training, livestock ownership and land use certification status. Thus, the result in table 4.10 shows that, more than half (54.31%) of the respondents don't have access to training in relation to soil and water conservation. In converse, 45.9% respondents responded that they sometimes got training on soil and water conservation practices. In connection to this, key informant interview participants in this issue indicated that most of the farmers in the district participated on orientation meetings and training on soil and water conservation practices. However, the KII participants admitted that the training has limitations in quality and coverage.

The household survey also captured livestock ownership of the respondents and hens the most majority (76.8%) of the respondents own livestock, which clearly manifests that the study communities are characterized by mixed farming practices. Here, the result is supported by the FGDs, which underlined that most of the farmers in the study are not engaged in soil and water conservation practices fearing that the livestock damage the SWC structures and biological measures, since they are practicing open grazing.

Table 4.10. Respondents access to training, livestock ownership & land certificate characteristics

Variables	Freq.	Percent	Cum.
Trainings			
No	145	54.31	54.31
Yes	122	45.69	100
Total	267	100	
Livestock ownership			
No	62	23.22	23.22
Yes	205	76.78	100
Total	267	100	
Land Certificate			
No	35	13.11	13.11
Yes	232	86.89	100
Total	267	100	

Source: 2021 field survey

Moreover, the result in table 4.10 shows that, most of the respondents (86%) have land use certificate. On remaining (13%) of the respondents responded that they have no land use certificate. However, the focus group discussion participants in this study argue that the certification assures only temporary land use right, thus still they have the issue of land insecurity, which is another challenge to develop their land through soil and water conservation practices.

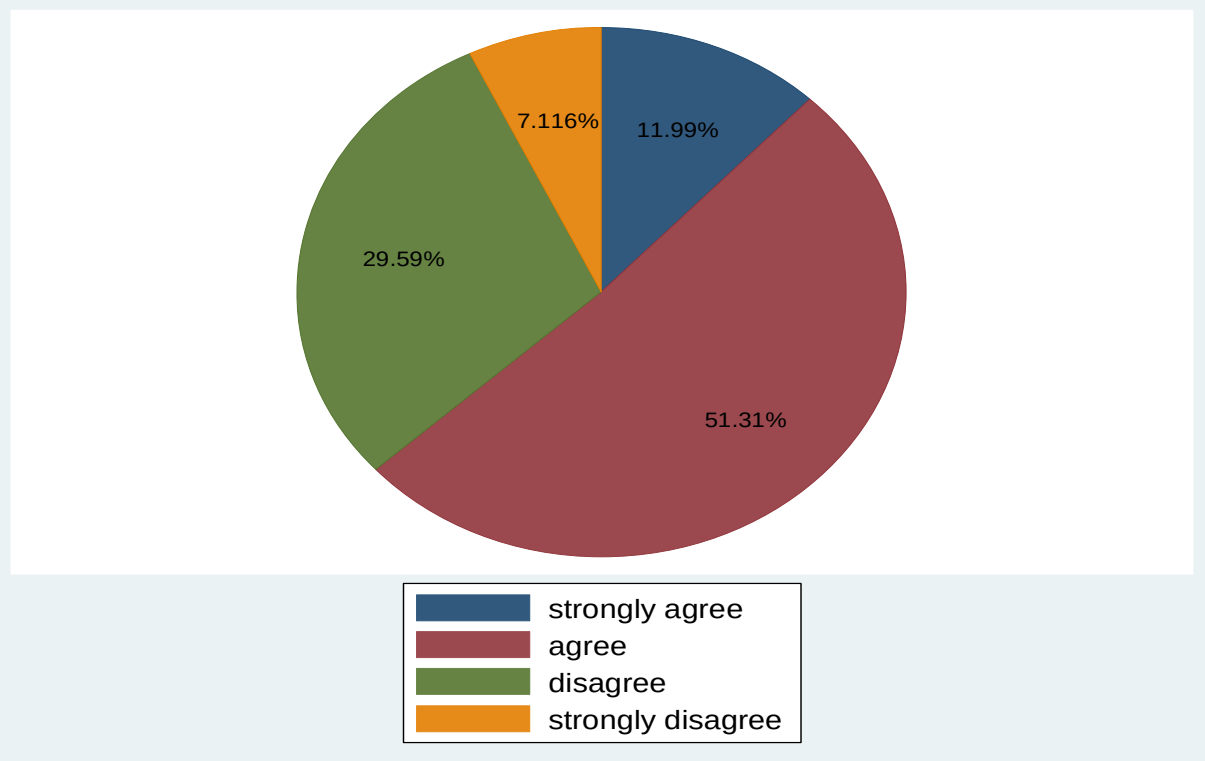

Figure 4.2. Erosion perception category of participants computed from STATA

The result on soil erosion perception of farmers observed from Figure 4.2 that the majority of the respondents (51%) agree that, there is soil erosion on their land. This clearly manifested most of the respondents perceive that their land is losing its fertility because of soil erosion. On the other hand (29%) of the respondents responded that they disagree on the soil erosion. The rest of the respondents (7%) and (11%) of the respondents are in a strongly disagree and strongly agree category.

4.6. Results of the Econometric Model

4.6.1. Assessment of goodness fit of binary logistic regression analysis

The goodness of fit of a model measures how well the model describes the response variable. Assessing goodness of fit involves investigating how close values predicted by the model are to the observed values. The appropriateness of the fitted logistic regression model needs to be examined before it is accepted for use as in the case of all regression models.

The validity of inferences drawn from modern statistical modeling techniques depends on the assumptions of the statistical model being satisfied. In order for the analysis to be valid, our model has to satisfy the assumptions of logistic regression, such as: Logistic regression requires the dependent variable to be dichotomous. The dependent variable is binary outcome taking 1 for adoption of soil and water conservation practice and 0 for not adopted. Larger samples are needed than for those in linear regression analysis. A minimum of 50 cases per predictor is recommended for logistic regression. Here in this study 267 samples are involved. There should be no high multi co linearity among the predictor variables. We do not have one unique method of detecting it or measuring its strength, but there are some rules of thumb. For instance variance inflation factor (VIF) test used to check the existence of the problem.

4.6.2. Result of binary logistic regression analysis

Logistic regression is used to analyze relationships between a dichotomous dependent variable and independent variables. Logistic regression combines the independent variables to estimate the probability that a particular event will occur. In this study, logistic regression was performed to assess the impact of independent variables on the adoption of soil and water conservation practice of households. The result of the binary logistic regression obtained from the STATA output is given in Table 4.11 which displays the coefficient, standard error, significance level and confidence interval.

Therefore, this study used a binary logistic regression model to estimate factors determining the adoption of soil and water conservation practice. The estimated model coefficients cannot be interpreted directly but they tell us much about the direction and significance of the predictor variables. Hence, in this study the determinants are identified by using the coefficients, while the magnitude of influence is expressed using the odds ratio in the next section of this study.

Table 4.11. Factors determining the adoption of soil and water conservation practice

Logistic regression		**Number of obs**	=	**267**
		Wald chi2(21)	=	49.39
		Prob > chi2	=	0.0004
Log pseudolikelihood	-15.9684	Pseudo R2	=	0.9130

			Robust			
Adoption of SWC	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
Age	0.079126	0.094809	0.83	0.404	-0.1067	0.264947
Sex	0.780942	0.83658	0.93	0.351	-0.85872	2.420609
Edu						
Grade 1-4	7.593734	2.351167	3.23	0.001	2.985532	12.20194
Grade 5-8	7.695758	1.835682	4.19	0.000	4.097887	11.29363
Grade 9-10	5.003593	3.693294	1.35	0.175	-2.23513	12.24232
Grade 11-12	5.962057	2.337111	2.55	0.011	1.381403	10.54271
FamSize	0.699847	0.820597	0.85	0.394	-0.90849	2.308187
LivestockHolding	-1.30056	1.573866	-0.83	0.409	-4.38528	1.784164
LandSize	-3.60347	1.531985	-2.35	0.019	-6.6061	-0.60083
Extension	14.23342	4.132155	3.44	0.001	6.134543	22.33229
Non-farmIncome	4.539581	1.660251	2.73	0.006	1.28555	7.793612
Credit	1.712095	1.091371	1.57	0.117	-0.42695	3.851143
sloppinessLand						
Agree	0.709292	1.290838	0.55	0.583	-1.82071	3.239289
Neutral	-1.26349	1.871148	-0.68	0.500	-4.93088	2.40389
Disagree	0.63526	1.620326	0.39	0.695	-2.54052	3.811041
strongly disagree	1.366228	3.587476	0.38	0.703	-5.6651	8.397552
LHcertificate	-0.75028	1.291277	-0.58	0.561	-3.28113	1.780581
Distance	-1.22159	1.5235	-0.8	0.423	-4.2076	1.764412
ErosionPerception						
Agree	0.777335	1.041081	0.75	0.455	-1.26315	2.817815
Disagree	-4.72539	2.013809	-2.35	0.019	-8.67238	-0.77839
strongly disagree	-10.6578	2.440319	-4.37	0.000	-15.4407	-5.87483
_cons	-11.1262	4.723652	-2.36	0.019	-20.3844	-1.86804

Source: 2021 field survey

Looking first at the education variable, the estimated logistic regression coefficients shows that education level (grade 1-4, grade 5-8 and grade 11-12) affects the adoption of soil and water conservation practice in a positive direction. The regression result indicated that joining grade 1-4, grade 5-8 and grade 11-12 increases the likelihood of adopting soil and water conservation practice among respondents which is significant at 95% confidence interval. The positive direction of respondents with education may be attributed to the increased understanding to perceive the worsening soil and water situation than those of the illiterates.

On the other hand the estimated logistic regression result coefficient show that land size determines the adoption of soil and water conservation practice among farmers in a negative direction. As the land size of the farmers increases the likelihood of adopting soil and water conservation practice decreases among respondents which is significant at 95% confidence interval. The negative direction may be because of the farmer's perception and reliance on the large size of their land make them less sensitive to conserve their land through soil and water conservation practice.

Further, the estimated logistic regression result coefficient indicates that access to extension service determines the adoption of soil and water conservation practice among farmers in a positive direction. Thus, when the farmers have access to extension service, the likelihood of adopting soil and water conservation practice increases among respondents which is significant at 95% confidence interval. The positive direction may be because of the farmer's access to extension service increases their knowledge to save soil and water conservation.

The estimated logistic regression result coefficient indicates that income from non-farm income determines the adoption of soil and water conservation practice among farmers in a positive direction. When farmers have income from non-agricultural sources, their likelihood of adopting soil and water conservation practice increases among respondents which is significant at 95% confidence interval. The positive direction may be because of the farmer's perception to enhance their non-farm income through soil and water conservation structures.

Furthermore, the coefficients for variable erosion perception show that it determines the farmer's adoption of soil and water conservation practice in a negative direction. As the farmers disagree and strongly disagree on erosion level of their land the likelihood of adopting soil and water

conservation practice decreases among respondents, which is significant at 95% and 99% level of confidence interval respectively. The negative direction of respondents may be resulting from their perception of good soil fertility status.

4.7. Determinants of the adoption of soil and water conservation

The odds ratio was computed to be used in order to show the magnitude of determination of independent variables on the dependent variable the adoption of soil and water conservation practice. Therefore, the binary logistic regression result displayed the proportional odds ratio as presented in Table 4.12 below.

Table 4.12: Factors determining adoption of soil and water conservation using odds ratio

Logistic regression		**Number of obs**	=	**267**
		Wald chi2(21)	=	49.39
		Prob > chi2	=	0.0004
Log Pseudo likelihood	= -15.9684	Pseudo R2	=	0.913

			Robust			
Adoption	Odds Ratio	Std. Err.	Z	P>z	[95% Conf.	Interval]
Age	1.082341	0.102615	0.83	0.404	0.898799	1.303362
Sex	2.183528	1.826696	0.93	0.351	0.423702	11.25271
Edu						
Grade 1-4	1985.715	4668.748	3.23	0.001	19.79704	199174.5
Grade 5-8	2199.001	4036.667	4.19	0.000	60.2129	80308.42
Grade 9-10	148.9474	550.1067	1.35	0.175	0.106978	207381.8
Grade 11-12	388.4081	907.7527	2.55	0.011	3.980483	37900.13
FamSize	2.013445	1.652226	0.85	0.394	0.403131	10.05618
LivestockHolding	0.27238	0.42869	-0.83	0.409	0.01246	5.954602
LandSize	0.027229	0.041715	-2.35	0.019	0.001352	0.548355
Extension	15.18781	6275838	3.44	0.001	461.5281	5.00E+09
NonfarmIncome	93.65155	155.485	2.73	0.006	3.616656	2425.062
Credit	5.540559	6.046806	1.57	0.117	0.652495	47.04682

sloppinessLand						
Agree	2.032552	2.623696	0.55	0.583	0.161912	25.51557
Neutral	0.282665	0.528908	-0.68	0.500	0.00722	11.06614
Disagree	1.887514	3.058387	0.39	0.695	0.078825	45.19747
strongly disagree	3.920535	14.06482	0.38	0.703	0.003465	4436.194
LHcertificate	0.472236	0.609788	-0.58	0.561	0.037586	5.933301
Distance	0.29476	0.449067	-0.8	0.423	0.014882	5.838137
ErosionPerception						
Agree	2.175666	2.265043	0.75	0.455	0.282763	16.74023
Disagree	0.008867	0.017857	-2.35	0.019	0.000171	0.459144
strongly disagree	2.35E-05	5.74E-05	-4.37	0.000	1.97E-07	0.002809
_cons	1.47E-05	6.95E-05	-2.36	0.019	1.40E-09	0.154427

Source: 2021 field survey

As the binary logistic regression model revealed in Table 4.12, educational status of the respondents, land size of the respondents, access to extension service, non-agricultural participation of the respondents were found to be significant in determining the probability of farmers to adopt soil and water conservation practice. We can interpret odds ratio in terms of the change in odds. If the value exceed one, then the odds of success (being adopter) is increases, if the value is less than one, any increase in the predictor variables leads to a minimize in the odds of adoption. The odds ratio gives the relative amount by which the odds of the outcome increase (if odds ratio >1) or decrease (if odds ratio <1) when the value of predictor is increased by 1 unit.

The predicted result of the binary logistic regression indicted that holding other factors constant, going from no formal schooling to grade 1-4 increases the odds of adopting soil and water conservation practice compared to those who have no formal schooling. In addition, when educational status of the respondents going from no formal schooling to grade 5-8, it increases the odds of adopting soil and water conservation practice compared to those who have no formal schooling. When educational status of the respondents going from no formal schooling to grade 11-12, it increases the odds of adopting soil and water conservation practice compared to those who have no formal schooling.

This might be explained by the fact that the formal education has found to increase the farmer's probability to adopt soil and water conservation practice. Formal education is said to provide farmers with greater capacity to learn and absorb new information about the adoption and conservation of soil and water resources. The result is in line with the findings of Ashoori et al, (2015), Belachew et al, (2020), Dilebo T, (2017) found that educational status has a positive influence on the adoption of soil water conservation practice among farmer household heads.

The result revealed that assuming all other factors remains constant, a unit increase in land size of the respondents decreases the adoption of soil and water conservation practice by 0.027 times. This may be because of the farmer's perception that, they have relatively large amount of farm land that is good alternative for them. This result is in line with the result of study conducted by Belachew et al, (2020), which indicates the amount of land size negatively affects the adoption of soil and water conservation practice.

Based on the results displayed in Table 4.12 an increased access to extension service increases the probability of adopting soil and water conservation practice by 15.18 times, assuming all other factors remains constant. The possible explanation for this might be access to extension service is the major opportunity given for farmer households. The result is in line with the findings of Belachew et al, (2020) and Dilebo T. (2017) they argue that access to extension service has a positive and significant effect on the adoption of soil and water conservation practice among rural farmer households.

The regression result revealed that assuming all other factors remains constant, the farmers engagement in non-farm income source, increase the odds of adopting soil and water conservation practice by 93.36 times compared to those who have no engagement in non-farm income sources. The positive direction may be because of the farmers hope to enhance their opportunity in non-farm income resulting from soil and water conservation structures. This result is in line with the findings of Ashoori et al, (2015), who found that farmers engagement in the non-farm income sources have a significant and positive effect on the adoption of soil and water conservation practice.

As the respondents level of agreement on the erosion of their land is disagree, the odds of adopting soil and water conservation practice decreased by 0.0088 times compared to those in a

strongly agree category, given all other variables are held constant in the model. The negative direction may be because of the farmer's perception or awareness on good fertility status of their land, which needs no soil and water conservation practice.

Further, the respondents level of agreement on the erosion of their land is strongly disagree, the odds of adopting soil and water conservation practice decreased by 2.35 times compared to those in a strongly agree category of respondents, given all other variables are held constant in the model. This result is in line with the findings of Dilebo T. (2017) who argues that when the farmers level of agreement on the level of erosion of their land decreases their probability of adoption for soil and water conservation decreases.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Based on the findings of the study, different factors were identified as responsible for hindering the adoption of soil and water conservation practice in Ankober District. To give conclusions about factors determining the adoption of soil and water conservation practice, the researcher combined both descriptive and inferential analysis results together. Also, the researcher focused on mean value of variables and percentage of the categorical response besides with focus group discussion result to identify the major factors constraining the adoption of soil and water conservation practices.

In the descriptive part of the study the result showed that 44.6% of the respondents adopted soil and water conservation practice. The result indicate on the type of soil and water conservation practices implemented in the study area are soil bund (37.8%), stone bund (30.7%), check dam (18%) and cut of drain (10.1%) conservation practices. The rest of (3.4%) of the respondents were adopted grass strip conservation practice.

The result indicated that females' participation in adopting SWC practice is (23.6%), which too low compared with males. Most of the land use practice is for ploughing purpose, which accounts (66.3%) of the respondents. From the result the study can conclude that (45.7%) of respondents have accesses to extension service. The observed dominance of male adopters is partly associated with the long time superiority of men in the rural economic activities including agricultural and resource management. Moreover as descriptive statistics indicated that the majority of the respondents in the area (54.7%) have no formal schooling followed by first cycle primary schooling, which accounts (20.2%).

From the binary logistic regressions result can be conclude that educational status, access to extension service and income from non-farm activity has a significant and positive effect on the adoption of soil and water conservation practice. In other words the increase in these variables results in increases the likelihood of adopting soil and water conservation practice.

On the other hand land size and land erosion perception of farmer households have a significant and negative effect on the dependent variable adoption of soil and water conservation practice.

The increase in these independent variables underestimated the likelihood of farmer household's adoption of soil and water conservation practice. Considering the results of odds ratio, the increase in these independent variables, the likelihood of farmer households to adopt soil and water conservation practice decreases.

5.2. Recommendations

Based on the conclusion reached above this study suggests the following recommendations as per the cross sectional study findings. Thus, the following actions are suggested for farmers, district level government actors and other stakeholders to improve the adoption status of soil and water conservation practice.

Integrated effort is needed among the governmental and nongovernmental organizations with full involvement of the farmer households to improve and enhance the adoption level of soil and water conservation practice.

Education should be enhanced that increases the level of awareness of farmer households to raise their likelihood of adoption of soil and water conservation practice. As the finding revealed that the variable access to extension service is crucial for the adoption of soil and water conservation practice. Therefore, the Ankober district administration should continue supporting farmers in terms of demand driven extension service on soil and water conservation in order to contributing to the natural resource management and environmental safety of the country. Non-farm income sources should be strengthened in a consistent way to enhance the adoption and even for sustainability of soil and water conservation practices.

Extensive awareness creation system should be created and strengthened to break the perception of farmers with a relatively large land size and not sensitive to adopt soil and water conservation practice. Likewise, non- formal(e.g., adult) education system need to be established parallel with the extension system to raise the level of awareness on soil erosion, environmental degradation and climate change at large to reduce the jeopardy from traditional farming practice.

Soil and water conservation practice is not a one-time process to happen, hence, it is better to consider time serious data in the subject matter in future studies rather than depending on cross-sectional data. In addition, to get a comprehensive understanding it is better to undertake experimental and quasi-experimental studies to see the level of soil fertility and take appropriate actions.

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ANNEXES

Addis Ababa University
College of Development Studies
Center for Environment and Sustainable Development

Dear/Sir/Madam,

This is a structured interview questionnaire prepared to undertake a study entitled "Factors determining the adoption of soil and water conservation practice in Ankober district, North Shewa Zone, Amhara National Regional State, Ethiopia.

Dear respondents, I am Fetlework Belet, a post graduate student in a Center for Environment and Sustainable Development, College of Development Studies, Addis Ababa University. Currently, I am planning to undertake a research in order to complete the requirements for Master of Arts degree in Development Studies (Environment and Sustainable Development) given by College of Development Studies, Addis Ababa University.

The research is conducted purely for academic purpose and all the information given are treated as confidential and will not be used for other purposes. I also assure you that no personal identity

will be disclosed to third parties. I am so grateful to you by giving reliable and appropriate data and information.

Thank you for your time and cooperation

Code ----------

Date of interview ----------

I. Structured Interview Questionnaire

1. Demographic and Socio-Economic Characteristics

S.No	Items	Options
1.1.	Sex of the household head?	1. Male 2. Female
1.2.	Age of the household head in years?	----------
1.3.	What is your level of educational?	1. No formal schooling 2. Grade 1-4 3. Grade 5-8 4. Grade 9-10 5. Grade 11-12 and above
1.4.	What is your family size	----------

2. Soil and water conservation practices characteristics

S.No.	Items	Options

2.1.	Do you adopt soil and water conservation structure on your land?	1. Yes 2. No
2.2.	What types of soil and water conservation practice do you adopt on your land? (multiple selection is possible)	1. Soil bund 2. Stone bund 3. Check dam 4. Cut of drain 5. Grass strip 6. Others
2.3.	How much year the soil and water conservation structure stay in your land?	----------

3. Farm and production related variables

S.No.	**Items**	**Options**
3.1.	Do you have income from non-farm activities?	1. Yes 2. No
3.2.	What is your total land size in hectare?	----------
3.2.1.	For what purpose you are using your land?	1. Ploughing ---------- hectare 2. Grazing ---------- hectare 3. Forestry ---------- hectare 4. Residence ---------- hectare 5. If any other ---------- hectare
3.3.	Do you have access to agriculture extension service?	1. Yes 2. No
3.4.	Do you have access to credit from financial institutions?	1. Yes 2. No
3.5.	What is your level of agreement on the sloppiness of your land?	1. Strongly agree 2. Agree 3. Neutral

		4. Disagree 5. Strongly disagree
3.6.	How do you rate the amount of yield earned per year in quintals?	1. Very good 2. Good 3. Neutral 4. Poor 5. Very poor
3.7.	What is the distance between your home and farm land in km?	----------

4. Asset ownership and awareness related variables

S.No	Items	Options
4.1.	Have you ever got access to agriculture related trainings?	1. Yes 2. No
4.2.	Livestock ownership in (2020)? Circle the one you have please?	1. Ox ---------- (in number) 2. Cow ----------(in number) 3. Horse ----------(in number) 4. Mule ----------(in number) 5. Donkey ----------(in number) 6. Sheep ----------(in number) 7. Goat ----------(in number) 8. Other ----------(in number)
4.3.	Do you have land holding certificate?	1. Yes 2. No

4.4.	Do you agree that your land is eroded?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

Thank you in advance for your time!

Annex II. Key Informant Interview Guidelines

1. How do you explain the soil erosion exposure in your area?
2. How do you explain the farmer's awareness on the soil erosion problems?
3. Is there any technical and financial support on soil and water conservation practice?
4. How do you evaluate the sustainability of soil and water conservation structures in the area?

Annex III. Focus Group Discussion Guiding Questions

1. What is the severity of soil erosion problem in your land?
2. What are the causes of soil erosion in your land?
3. Do you think that soil and water conservation practice will save your land from erosion?
4. What merits do you get from practicing soil and water conservation in your land?

Thank you for your time!

Annex VI. Stata Computational Output

. tab Edu

educational status of farmers	Freq.	Percent	Cum.
No formal schooling	146	54.68	54.68
Grade 1-4	54	20.22	74.91
Grade 5-8	34	12.73	87.64
Grade 9-10	21	7.87	95.51
Grade 11-12	12	4.49	100.00
Total	267	100.00	

. tab LivestockHolding

Livestock ownership	Freq.	Percent	Cum.
No	62	23.22	23.22
Yes	205	76.78	100.00
Total	267	100.00	

. tab typeSWCP

Type of SWCP	Freq.	Percent	Cum.
soil bund	101	37.83	37.83
stone bund	82	30.71	68.54
check dam	48	17.98	86.52
cut of drain	27	10.11	96.63
grass strip	9	3.37	100.00
Total	267	100.00	

. tab Sex

Sex of the household head	Freq.	Percent	Cum.
female	63	23.60	23.60
male	204	76.40	100.00
Total	267	100.00	

. tab Adoption

Do you adopt SWC practices	Freq.	Percent	Cum.
No	148	55.43	55.43
Yes	119	44.57	100.00
Total	267	100.00	

. tab ErosionPerception

Farmers perception on land erosion	Freq.	Percent	Cum.
strongly agree	32	11.99	11.99
agree	137	51.31	63.30
disagree	79	29.59	92.88
strongly disagree	19	7.12	100.00
Total	267	100.00	

. tab landUse

land use of the household head	Freq.	Percent	Cum.
ploughing	177	66.29	66.29
grazing	59	22.10	88.39
forestry	7	2.62	91.01
residence	15	5.62	96.63
other	9	3.37	100.00
Total	267	100.00	

. sum Age FamSize Sustain_SWC LandSize distance

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	267	38.71536	10.03909	26	78
FamSize	267	3.041199	.974384	2	6
Sustain_SWC	267	3.389513	1.859229	1	8
LandSize	267	.9540449	.6168896	.2	2
distance	267	1.416479	.7299899	.2	3

Logistic regression — Number of obs = 267
Wald chi2(21) = 49.39
Prob > chi2 = 0.0004
Log pseudolikelihood = -15.968375 — Pseudo R2 = 0.9130

Adoption	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age	.0791259	.0948086	0.83	0.404	-.1066955	.2649473
Sex	.7809421	.8365799	0.93	0.351	-.8587244	2.420609
Edu						
Grade 1-4	7.593734	2.351167	3.23	0.001	2.985532	12.20194
Grade 5-8	7.695758	1.835682	4.19	0.000	4.097887	11.29363
Grade 9-10	5.003593	3.693294	1.35	0.175	-2.23513	12.24232
Grade 11-12	5.962057	2.337111	2.55	0.011	1.381403	10.54271
FamSize	.6998472	.8205966	0.85	0.394	-.9084926	2.308187
LivestockHolding	-1.300556	1.573866	-0.83	0.409	-4.385276	1.784164
LandSize	-3.603468	1.531985	-2.35	0.019	-6.606103	-.6008323
Extension	14.23342	4.132155	3.44	0.001	6.134543	22.33229
NonAgriIncome	4.539581	1.660251	2.73	0.006	1.28555	7.793612
credit	1.712095	1.091371	1.57	0.117	-.4269524	3.851143
sloppinessLand						
agree	.7092921	1.290838	0.55	0.583	-1.820705	3.239289
neutral	-1.263493	1.871148	-0.68	0.500	-4.930876	2.40389
disagree	.6352604	1.620326	0.39	0.695	-2.54052	3.811041
strongly disagree	1.366228	3.587476	0.38	0.703	-5.665096	8.397552
LHcertificate	-.7502766	1.291277	-0.58	0.561	-3.281134	1.780581
distance	-1.221593	1.5235	-0.80	0.423	-4.207597	1.764412
ErosionPerception						
agree	.7773347	1.041081	0.75	0.455	-1.263146	2.817815
disagree	-4.725385	2.013809	-2.35	0.019	-8.672378	-.7783915
strongly disagree	-10.65776	2.440319	-4.37	0.000	-15.4407	-5.874826
_cons	-11.12622	4.723652	-2.36	0.019	-20.38441	-1.868035