

COLLEGE OF DEVELOPMENT STUDIES

CENTRE FOR ENVIRONMENT AND DEVELOPMENT

DETERMINANTS OF CONTINUED USE OF SOIL AND WATER CONSERVATION MEASURES: THE CASE OF KUYYU DISTRICT OROMIA NATIONAL REGIONAL STATE, ETHIOPIA

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This is to certify that thesis prepare by Tesfaye Woldeyesus , entitled :Determinants of continued use of soil and water conservation measures the case of Kuyu District Oromia National Regional State, Ethiopia and submitted in partial fulfillment of the requirements for the degree of Master of art(Environment and Sustainable Development) compiled with the regulation of the university and meets the accepted standards with the respect to originality and quality.

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DECLARATION

I, hereby declare to school of graduate studies of Addis Ababa University ,that this thesis entitled "determinants of continued use of soil and water conservation measures :The case of Kuyu District,Oromia National Regional State, Ethiopia" is my original research work for the master's degree of Environment and Sustainable Development and has not been presented in any university. For the best of my knowledge, all resources of materials and information used in the study are fully acknowledged and referenced based on the standard and regulation of the university.

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ACRONYMS AND ABBREVIATIONS

CBOS Community Based Organization

CFW Cash For Work

CSA Central Statistics Agency

DA Development Agent

EGA Income Generating Activities

FFW Food For Work

FGD Focused Group Discussion

FTC Farmers Training Center

Ha Hectare

HH House Hold

Km^2 Kilometer Square

Masl Meter above sea level

mm millimeter

NGO Non- Governmental Organization

PA Peasant Administration

PSNP Productive Safety Net Program

PSWC Physical Soil and Water Conservation

SWC Soil and Water Conservation

TLU Tropical Livestock Unit

UNCCD United Nations Convention to Combat Desertification

WFP World Food Program

ABSTRACT

The land degradation is one of the major challenges in agricultural production in many part of the world especially in developing countries like Ethiopia. Even though SWC is one of the practical ways to reverse the threat and hence a number of SWC methods were introduced to combat land degradation the level of using in a sustainable manner and adoption practice is remains below expectation. The purpose of the study was aimed to investigate the determinants of continued use of soil and water conservation measures in Kuyyu District, Oromia region, Ethiopia. The study was based on primary data collected from 339 samples selected at random using a household survey questionnaire from two PAS. Additional information was also obtained from focus group discussions, key informant interviews, and personal observation. The data has been *analyzed by descriptive statistics and econometric model (Binary logit and tobit regression) using STATA software.. When determinants of continue use of SWC measure were analyzed and testing using descriptive statistics the statistical level of T-value and chi-square, mean, standard deviation and percentage types were applied. The descriptive analysis pointed out that of total 339 samples HHs randomly selected 250 were maintained the SWC practices while 89 were either removed or not maintained regularly. The result from binary logit regression confirmed that educational level, slope, degree of erosion, year of plot management, off-farm activity, access to credit, age. Marital status, family size and agricultural extension contact found to be significant and except family size and age all are affected positively farmers' decision to use and maintain soil conservation technologies. In similar way the tobit regression analysis revealed that among sixteen explanatory variable fourteen of them were found to be significant on decision to maintain the selected three types of SWC measures namely soil bund, stone bund and hill side terrace. The analysis of the households' attitude indicated that that majority have positive view regarding SWC technologies so that enabled them to maintain regularly while attitudes that undermine the severity of soil erosion were found to be challenges for most of the respondents. Like other significant explanatory variables the high extension visit and low level age respondents were more likely decide to maintain the SWC technologies. The recommendation is suggested to apply proper strategy, prefer to conserve fertile soil type before degraded, minimize implementation failures, promoting access to credit, education and innovation, participatory approach, agricultural extension contact, improved livestock management and appropriate technology*

Key words: *Continued use, Determinants, Kuyyu District, Maintain,SWC,*

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

The Ethiopia economy is heavily dependent on agriculture which is mainly dominated by subsistence small holder farmers that are partially integrated in to markets. The fate of agricultural sector directly affects economic development, food security and poverty alleviation. However the role of this agricultural sector in alleviating poverty and food insecurity is undermined by land degradation such as soil erosion and nutrient depletion (Bekele and Drake 2003; Teshome,and Kassioe 2015)

To alleviate the problems over the last four decades, the Government of Ethiopia ,NGOs and donors have been promoting soil and water conservation technologies in high lands of Ethiopia for improving agricultural productivity, household food security and rural livelihood while simultaneously mitigating environmental degradation. Previously the importance of soil and water conservation was largely neglected in Ethiopia prior to 1974.The problem attracted the attention of Government policy makers and international donors only after the disastrous drought and famine of 1974.An effort to halt the problem of soil erosion started after the Ethiopian Government initiated massive soil conservation programs following the 1975 land reform.(kruger *et al* 1997)

Large numbers of conservation and afforestation projects were undertaken by food for work programe (Hurni 1988; Teshome 2015). This massive campaign in soil and water conservation under food for work did not bring a wide dissemination, adaptation and sustainable use of practices by farmers. Most of the conservation measures were removed after the Government changed in 1991 (Shiferaw and Holden 1998; Teshome 2015)

Between 1995 and 2009, soil conservation activities have been undertaken as part of the agricultural extension package of the Government through mass mobilization with a top- down approach and without incentives for the time farmers spent on soil and water conservation activities. The emphasis was given to the quantity rather than quality of measures. Non adoption and problem of continued use in soil and water conservation measures were common phenomenon in this period. This indicates that the extension system did not bring about behavioral change among farmers probably because the focus was on changing the farm land rather than farmers behavior. (Teshome;2015)

Since 2010 the Government of Ethiopia has embarked again on conservation campaign .The approach is mass mobilization that focus at water shed level that attempt to make the programe more participatory .In each watershed area agricultural offices along with local Administrators organize 15

days farmers work shop to create awareness about the problem of soil erosion and its cause. During the work shop farmers prioritize their major natural resource problems, causes and possible solutions .then they reach consensus about natural resource problems and required collective actions (Teshome;2015)

Therefore better understanding and identifying of constraints that the condition farmers to use and maintain the conservation technologies that varies greatly is therefore important for designing policies that enable to sustain and stimulate practices of soil and water conservation and enhance agricultural productivity.

In the first stage this study was conducted to identify the factors that determine continued use of soil and water conservation in Kuyu District which located in North Shewa Zone,Oromia regional state that found 156 km in North West Capital city of Addis Ababa of which the agro ecology includes low land ,mid land and high lands and the topography of the land scape is susceptible to erosion and hence made suitable for practicing SWC measures.

1.2. Statement of the problem

Land degradation is one of the major challenges in agricultural production in many part of the world particularly developing countries like Ethiopia. Even though SWC is one of the practice way to reverse the threat and hence a number of SWC methods were introduced to combat land degradation the level of using in a sustainable manner and adoption practice is remains below expectation (Tsegaye and G/Mikael 2014)

In Ethiopia the Oromia regional state in general and Kuyu District in particular are affected by drought and soil erosion which consequences are resulted in deteriorating the productivity of land and caused low crop production. The topography, landscape and frequent cultivation of the crop production practices in Kuyu district made susceptible to soil erosion which finally leaded to implementation of different types SWC measures by the NGO, Productive Safety Net Program (PSNP),World Food Program (WFP) and by regular program of Government to mitigate the situation. However, despite the magnitude of soil erosion and efforts made to address the issue in this area mainly in past few years, conservation technologies are still not widely adopted and effectively practiced in the farming communities rather most farmers are interested either to reject totally or being unwillingness to maintain the conservation structures installed in their plots of land. This is happening due to different determinants that affect farmers' decision to use and maintain conservation structures which was already constructed by mass campaigns and individuals initiatives. (Tsegaye

and G/Michael 2014)

To Identifying clear knowledge of local farmers that determine the farmer's decision is an essential part combating severe soil erosion .because local farmers ultimately determines the use of SWC measures. These farmers may not believe that these measures are effective or may not have socio-economic challenges that restrict use and maintain of SWC technologies.(Jawaro 2008 and Abuhay 2017)

Previous studies show that various personal, economic, socio-institutional and biophysical attributes have influential roles in farmer's decision to use the SWC measures in different parts of Ethiopia and different studies conducted recently pointed out that there are sites and conditions for success and failure of SWC in the Ethiopian highlands. However, the success and failure of SWC structures and their relationship to socio-economic, environmental factors (e.g. topography) and regarding the relationship between the attributes and its positive and adverse impact has not yet been studied in the study area for variety of reasons. (Aseffa: 2009)

Appropriate understanding of these factors inKuyu District that affect use and maintain of SWC technologies is critical and would assist planning and designing outreach programmes via formulation and implementation of the policy intervention designed to induce voluntary continues use of SWC measures in high lands of Ethiopia. Given these facts my study tries to provide explicit empirical evidences about the dominant determinant factors that affect the sustainability of SWC measures as the country seeks ways to adopt the effect of climate.

1.3. Objective of the study

1.3.1. General objective

To investigate the determinant factors determine the continued use of SWC practices in Kuyu District Oromia region.

1.3.2. Specific objectives:

- To examine the socio-economic ,institutional and biophysical factors determining continued use of SWC practices implemented over the last five years
- To analyze farmers perception on soil erosion problem
- To identify the physical SWC practices implemented over the last five years
- To examine factors determining selected SWC practices implemented over the last five years

1.4. Research questions

1. What are the dominant socio-economic, institutional and biophysical factors affecting the SWC practices implemented over the last five years?

2 How do farmers understand or perceive erosion problem and the positive role as well as adverse effects of introduced SWC measures?

3. Which of the constructed physical soil and water conservation measures are implemented over the last five years?

4. What are factors influencing selected SWC practices implemented over the last five years and other available opportunities for improvement?

1.5. Significance of the study

In Ethiopia, the analysis of the determinants of continued use of SWC practices is limited and scanty. This study was conducted at woreda level and considered determinants of continued use of SWC measures of a limited area. The study's findings will provide necessary ideas for environment and development practitioners, policymakers, and researchers to develop strategic interventions to sustain the implemented SWC practices with common characteristics based on the local context. Other areas found in similar situations to the study area may also benefit from the knowledge generated by this study. Moreover, it would also provide baseline knowledge for other researchers who want to undertake further research similar to this study.

1.6. Scope and Limitation of the study

Geographically, the study was conducted in the Kuyyu district of North Shewa Zone Oromia region. The data needed for the research was collected in 2022 and analyzed for MA thesis fulfillment in 2022. It was to investigate "determinants of continued use of SWC measures" in the study area. The research involves rural households, development agents, and government officials to get complete information about the issue under question. The principal concern of this study was to identify and investigate key socio-economic, institutional and biophysical factors that determine continued use of SWC practices implemented over the last five years. Addressing all dimensions of determinants of continued use of SWC practices in this research is difficult due to limited financial resources and time. In addition to financial and time limitations, this research is also difficult due to the absence of documentation and an organized data base system in the study area and the absence of officials and some experts from the office during data collection.

Therefore, caution must be taken while using the result of the study as it is applicable only to the study area and other areas with similar socio-economic and institutional settings

1.7. Organization of the thesis

This thesis was consisting of four chapters. The first chapter is an introduction part which highlights the back ground of the study, statement of the problem, rational and significance of the study, Limitation of the study ,research objective, research question, organization of the study and ethical consideration was discussed .The second chapter was discussed review of related literature, on definitions , concepts, theory of SWC measures , empirical evidences on factors affecting continued use of SWC measures, and conceptual frame work of the research that was explained . The third chapter is about methodology of the study which includes description of the study area, research design, types and source of data collection, sampling techniques, sample size determination, data collection methods and instruments, method of data analysis, model specification, definition of variables and working hypothesis and summary of dependent and explanatory variables/. The fourth chapters were mainly focused on findings and discussion on determinants of continued use of SWC measures in Kuyu District. The fifth chapter was addressed summary, conclusion and recommendation.

1.8. Ethical Consideration

According to Krueger and Neumann (2006) there should be a balance between two values in ethical issues, the pursuit of scientific knowledge and the rights of those being studied or other members of the society. As stated by Walliman (2011) working with human participants in research practice always raises ethical issues. Accordingly, people involved in any research should be treated with respect during and after research. Krueger and Neumann (2003) also explained that social sciences research is never to coerce to anyone in to participation; participation must be voluntary. Accordingly, the researcher was not force anybody to participate in this research. All the respondents was participated in this research process after they dully expressed their willingness to do and also this was acknowledged by their signature on the consent form.

Privacy is the other moral issues that need to be reconsidered in this subject of study. Kruegerand Neumann (2006) explained that researcher needs to protect the privacy of the subject of the study throughout the study period. When a researcher assured and give confidence to the participants, he or she may get the right information or data, so that the researcher is required to provide full information about the purpose and objective of the study and must assured that this research is only used for academic purpose. The respondents that was identified not in any way be exposed other than for the said purpose. Walliman (2011) also raised two aspects of ethical issues in research process. The individual values of the researcher relating to honesty, frankness and personal integrity is the first issue. The second and most necessary aspect mentioned by Walliman (2011) is the issue of confidentiality, anonymity and courtesy. In line with this, the researcher from was informed the goal and objective of the research.

In this study the respondents were well informed about the objective and the purpose of the study. The researcher guaranteed the respondents that their response was only used for the purpose of the research. Furthermore, their property and identity were secured and unidentified for anybody. Since this is a voluntary activity or support, any respondent who refuses to be interviewed was not being forced to get his/ her response.

CHAPTER TWO: LITERATURE REVIEW

2.1. Theoretical review

2.1 .1 Definition and basic concepts on land degradation and conservation measures

Land degradation: is defined as 'the temporary or permanent wiring of the productivity of land.(Young, 1997).Young indicates different types of land degradation that include, soil erosion, soil fertility decline, salinization, water-resource degradation, Forest clearance and degradation, Pasture-resource

Land management: degradation, and loss of biodiversity. The teleology, activities and strategies employed by land users to manage their land. Land management is sustainable when the available technology, activities and strategies are employed and Integrated in such a way as to optimize the current and future land use in food production while maintaining the quality of the natural resources base.

Soil and water conservation: Soil and water conservation is the opposite of land degradation, and aims at preventing, reducing or recovering losses of soil, water and plant nutrients. SWC is the foundation of, sustainable land management, given that availability and quality of soil and water are crucial for food production and a healthy environment.

2.1.2 Land degradation and soil erosion in Ethiopia

Declining Ethiopia's agricultural productivity is both a cause and a consequence of deterioration in the natural resource base on which agriculture depends. According to the UNCCD (United Nations Convention to Combat Desertification), degradation of land involves the reduction of the renewable resource potential by one or a combination of processes acting upon the land. In general land degradation implies temporary or permanent regression from a higher to a lower status of productivity through deterioration of physical chemical and biological aspects (ponniah 1998).

Direct causes of land degradation are apparent and generally agreed, including production on steep slopes and fragile soils with inadequate investments in soil conservation or vegetative cover, erratic and erosive rainfall patterns and declining use of fallow Furthermore, limited recycling of dung and crop residues to the soil, limited application of external sources of plant nutrients, deforestation and overgrazing play a significant role in land degradation. There are many underlying causes of land degradation In Ethiopia, including population pressure, poverty, high costs and limited access to agricultural inputs and credit, low profitability of agricultural production and many conservation

practices, high risks facing farmers and insecure land tenure. Also the short time horizon of rural households and farmers' lack of information about appropriate alternative technologies are important aspects concerning land degradation. Broadly speaking, causes of land degradation in Ethiopia can be grouped into two categories: natural and man-made causes. The basic man-made factors that ultimately trigger the processes contributing to land degradation are increasing pressures from removal of vegetation cover, poor land use, insecure land tenure, inappropriate land management practices and poverty. Extensive farming systems, which were traditionally in harmony with the environment since only low production was demanded, become inappropriate. Moreover, increasing numbers of the rural population are being forced to farm marginal and unsuitable land, which shell quickly becomes degraded. For example, cultivating hillsides without adequate preventive measures leads to water erosion and leaving soils exposed during fallow periods often leads to wind erosion (yazie 2013).

2.1.3 Soil and water conservation practices

Preventing soil from erosion relies on selecting appropriate soil and water conservation strategies which in turn requires a thorough understanding of the process of erosion (Morgan, 1995). SWC practices are important in controlling the loss of nutrients from agricultural land; prevent pollution of water bodies, decrease rates of sedimentation in water bodies and to limit crop damage by windblown deposits or burial beneath water. Interest in controlling soil erosion and maintaining soil quality has been stimulated by renewed awareness that soil is vital to both the production of food and fiber and global ecosystem function (Norton *et al*., 1999).

The main focus of soil conservation is to reduce soil loss and run-off. It is not clearly known, however, if it is economically justifiable in different contexts to invest in soil conservation measures. To reverse the problem of land degradation, it is important to understand the actual impact of land management technologies on resource poor farmers and identify constraints thatinhibit sustainability of these measures. Empirical studies assessing the productivity and production risk impacts of Land management technologies used in the Ethiopian highlands are quite limited

Few empirical studies have directly examined the impact of soil conservation on mean yield using econometric and cross-sectional data (e.g., Shively 1998a, 1998b, 1999; Bekele 2003; Kaliba and Rabele, 2004).

A conservation technique may be regarded as successful if it reduces the rate of soil loss to less than 20 percent of the rate without conservation and to less than 10 t ha year which is the commonly

accepted as a 'tolerable' rate of erosion (Young, 1997). Primary principles of controlling soil erosion by water include reducing raindrop impacts on the soil, reducing runoff volume and velocity and increasing the soils resistance to erosion (Troeh *et al*., 1980). The function of terraces in humid areas are to decrease the length of hillside slopes and thereby reduce erosion and allow for sediment to settle, whereas in drier areas it serve to retain runoff and increase water available for plant growth (Schwab *et al*., 2002).

Accelerated soil erosion is a result of the operation of the physical forces of wind and water on soil, which has become vulnerable, usually because of human interference with the natural environmental. For this reason, soil erosion can be viewed as a symptom of bad land use and management. Soil conservation refers to the protection of fertile top soil from erosion by wind and water and the replacement of nutrient in the soil by means of cover crops, terracing, contourfarming crop rotation etc. SWC can define as the combination of the appropriate land use and management practices that promotes the productive and sustainable use of erosion and other forms of land degradation (Senders 2004). SWC is not restricted to the protection of the threatened hillside or their rehabilitation by planting of trees. Its scope is much larger and it involves the whole agricultural and natural resource conservation. Generally, soil and water conservation includes all forms of human action to prevent and treat soil degradation (IIED, 1998).

The aim of soil-water conservation is to facilitate optimum level of production from a given areaof land while keeping soil loss below a critical value and protections of the life supporting capacity of soils such as soil quality, soil depth, soil structure, water holding capacity and soil productivity (Addisu,2011)

2.1.4. Soil and Water Conservation practices in Ethiopia

Prior to the 1974 revolution, soil degradation did not get policy attention it deserves (Wogayehu and Lars, 2003). The famines of 1973 and 1985 provided a movement for conservation work through large increase in food aid mainly using imported grains and oil. Following these severe famines, the government launched an ambitious program of soil and water conservation supported by donor and non-governmental organizations (Hoben, 1996). The use of food aid as apayment for labor replaced voluntary labor for conservation campaigns (Campbell, 1991).

The extent of conservation activities using food aid escalated tremendously and the conservation

continued to grow arithmetically though the implementation could not keep pace with the plan. Up to 1986, food aid used for payment of conservation and related works as food-for-work payment accounted for approximately 29% of total food aid (71% of the food aid was distributedas emergency food). With this, Ethiopia became the largest food–for-work program beneficiary in Africa and the second largest country in the world following India. Eighty hundred fifty workdays were devoted to the conservation work between 1982 and 1985 through food-for- work. During 1980s, the government of Ethiopia launched a massive program of soil and water conservation and rehabilitation. As Herweg, (1993) stated in his study after 1989 soil and water conservation practices have mainly been undertaken in a form of campaign and quite often farmers have not been involved in the planning process. It is after this period that national effortsfor soil-water conservation expanded rapidly.

Farmers in the northern, central, and southern parts of Ethiopia construct stone terrace on their sloping lands to protect them from erosion and land sliding. In most cases, the terraces are not Protected with vegetable cover. The FFW and CFW programmers were fundamentally top-down,with little involvement of local beneficiaries. Moreover, the programs focused on promoting Conservation practices on community lands with minimal consideration given to individual farms.

However, they expect of farmers participation and the impact of these approaches on sustainability of conservation practices were limited. A real involvement and participation of farmers could not be realized the lack of prior research and scientific base of soil and water conservation programmers was also manifested by the little consideration given to conservation needs at the waters shad level.

The physical appropriate special units for research on resource conservation issue are watersheds. The watersheds context provide the natural framework for investigation into the complex and reciprocal linkage among land use, soil and water resource; the inter dependence of people in their resources (Girma, 2001)

2.2. Empirical review on factors determining continued use of soil and water conservation structure

A sustainable use of agricultural technologies is influenced by a number of interrelated components within the decision environment in which farmers operate. For ease of grouping, thefactors identified as having relationship with use and maintain SWC measures are categorized as household's demographic, economic, social and institutional factors.

2.2.1. The household's demographic factors

Household's demographic factors (age, sex and education) are among the most common household characteristics which are mostly associated with farmers' using in sustainable manner of attitudes. Age of the household head is an important factor affecting adoption of agriculturaltechnology. Age is said to be primary latent characteristics in decision to use and maintain. .However there is contention on the direction of the effect of age on sustainability. Age was found to positively influence on adoption decision and intensity of SWC measures in Dedo district, western Ethiopia (Anley et al., 2007).

The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. However, age has also been found to be negatively correlated with sustainability or not significant in farmers' use and maintain decisions. In this line, the result of the study undertaken by Million and Belay (2004) shows that age has significant but negative influence on the adoption of fertilizers.

The study conducted in Anna water shade, Hadiya zone by Habtamu (2006) revealed that age of the household head was negatively influenced adoption of physical SWC structures. Similarly, studies by Paul (2011) and Yitayal (2004) reported that age has negative influence on the adoption of agricultural technologies.

Sex of the household head is one of the important factors influencing sustainable use of improved agricultural technologies. Due to long lasted cultural and social grounds in many societies of developing countries, women have less access to household resources and also have less access to institutional services. Regarding the relationship of household's sex with adoption and sustainable use of agricultural technologies, many previous studies reported that male- headed households are more likely to adopt new technologies than their female-headed counterparts.

In this regard, Techane (2002) indicated that male farmers are more likely to adopt,use and maintain agricultural technologies than female farmers. Studies carried out by Tesfaye (2006) and Aziz (2007) further indicated that male headed households are more likely to adopt rain water harvesting technologies. Similarly, Almaz (2008) have revealed a significant relationship between adoption decision and sex on the household head. They reported that the likelihood of adoption is higher among male headed farm households than female headed households. In addition, Abrahaley (2006) and Gebresenbet (2008) indicated that the likelihood of adoption of agricultural innovation is higher among male-headed farm households than femaleheaded ones.

With regard to education, there is a general agreement that educations is associated with adoption, use and maintain because education is believed to increase farmers' ability to obtain and analyze information that helps them make appropriate decision. Education was found to positively affect adoption and sustainability of improved maize varieties in West Shoa, Ethiopia (Alene et al., 2001). According to Mishra and Rai (2013), education level of the household head was positively and significantly influenced the probability of use of indigenous soil and water conservation among farmers in Sikkim Himalaya. Moreover, Mahilet (2013) reported that education was found to positive and significant effect on factors influencing adoption and sustainability of improved rice technology package among smallholder farmers in Fogera district, southern Gonder, Ethiopia.

In the other words education influences farmers decision to adopt technologies by enhancing farmers ability to obtain, understand and utilize the practice, and by improving overall managerial ability of farmers (Etana 1985) many previous studies indicated that educational attainment affects conservation measures adoption decision positively. Ervin and Ervin (1982) found that education was significantly related to conservation efforts. According to them, farmers who are more educated are more likely to use contouring, minimum tillage and hay or pasture rotation to control soil loss .According to Saliba and Bromley (1986), education enhances farmers' willingness to 15 adopt new management practices by improving the managerial capacity of a farmer. Long (2003), predicted the positive and significant association between education and adoption of conservation measures. Traore etal (1998) supported the above findings and concluded that education is an influential factor in the adoption of practices that conserve soil and water.

Generally, most of the studies which undertaken previously clearly indicated that when the farmers are educated more and more, they tended to adopt and apply different soil and water conservation technologies as well as have the intention to maintain once constructed conservation structure which ensure the sustainability of soil and water resource management.

2.2.2 Physical factors

Physical factors are well established and crucial actor in the soil erosion process and for SWC and hence serving as a foundation for the technical options. So, physical characteristic played an important role in shaping farmers' SWC decisions. These are outlined below:

Slope: Like rainfall and nature of soil that affect erodibility, slope of a field affects the rate and amount of soil loss from fields. Farmers take SWC practices more seriously when they are farming on steep land. Farmers in Konso started a unique SWC system because their land scape is dominated by steep slopes (Tesfaye,2003). This forces farmers to control or mitigate the impact of erosion on fields that are situated in steep slopes and hence slope influences the decision of farmers to undertake conservation measures. Saliba and Bromley (1986) observed that farmers cultivating steep slope fields install more effective conservation measures than farmers that cultivate level fields. On the contrary, farmers in less erosion prone areas (level fields) do not employ conservation measures on their farmlands. They observed frequent conservation practices installed on steeply sloping cultivation fields which reflect the desire of farmers to control soil loss from highly erodible soil. Tesfaye (2003) and Woldeamlak (2003) found positive association between existence of recommended type of conservation structures and concluded that slope affects farmers' decision to adopt conservation structures positively.

The range of the slope- Range -based categorization of slope classes Range (%) flat or almost flat 0-3, gently sloping 3-8, sloping 8-15. moderately steep 15-30, Steep 30-50 ,very steep >50

Source: MoARD, 2005

Soil Fertility*:* Farmers will not be interested to invest in conservation and bear associated risks if they do not perceive significant threat posed on productivity due to soil erosion (Wagayehu andLars, 2003). Farmers perceive the effect of soil erosion when it reaches some critical level, which is very difficult to reverse the degradation at the subsistence farmer level (Woldeamlak 2003). On deep or fertile soil, erosion process does not affect farmers at least in the short term. The symptoms of erosion can be easily plowed away and on such sites there may not be a big effect on productivity of land although the problem is recognized. Fanners cultivating such lands are reluctant to apply soil conservation measures. In contrast to this, Wu and Babcodk (1998) found that farmers that cultivate low quality land adopt conservation practices less frequently. This is supported by Wagayehu and Lars (2003). They used soil color as a proxy to soil ferity and found negative correlation between black colored soil (fertile soil) and no conservation decision indicating that the tendency of farmers to invest more to conserve black (fertile soil) where the marginal loss of productivity due to erosion is higher.

Proximity: Farmers residing close to their cultivation land invest more on soil conservation measures than their counterparts living at distance. This is because cultivation land closer to the residences receives more attention and supervision than land that is situated at the farthest distance. Farmers also want to invest more in the field that require least effort (Kessler, 2006). He also found out that farmers invest more in soil and water conservation in fields situated near to residences. Wagayehu and Lars (2003) found significant and positive correlation between distance of the plot and adopting conservation decision. They attributed the negative association for the location factor that increases the labor cost due to time spent on travel.

2.2.3 The economic factors

Economic factors influence household's adoption decision and sustainable use of agricultural technologies. In this study, economic factors such as total land holding, livestock ownership, non-farm activity and availability of labor would be assumed to play a great role in determining the willingness and ability to invest in sustainable method of agricultural technologies. Farm size influences different farming communities differently in their adoption decision process.

Several empirical adoption literatures focus on farm size as the first and probably the most Important determinant. Studies conducted in different areas were showed mixed result. Seid(2009) has found a significant positive relationship between farm size and adoption of conservation measures indicating that the larger the farm size, the greater the probability of adopting the conservation structures. According to Aziz (2007) farm size had positively and significantly affected the probability of adoption and intensity of rain water harvesting technologies.

Contrary to these results, the empirical results from Endrias (2003) and Abrahaley (2006) have found that farm size influenced the probability of adoption and sustainable use of agricultural technologies negatively. In rural context, livestock holding is an important indicator of household's wealth position. Livestock ownership of a household influences the adoption of improved agricultural technologies differently by different people across different areas. In mostcases, livestock holding has positive contribution to household's sustainable use of agricultural technologies.

This is evident from many of the past adoption studies which have reported positive effect of livestock holding on adoption. To mention some of them, for instance, Dereje (2008) have foundthat livestock holding has positive and significant influence on adoption of improved agricultural technologies. Contrary to the above findings, Mesfin (2006) reported that livestock holding

influenced negatively the farm level adoption of farmers' participation on soil erosion and decision on land management. His explanation for this reason is that livestock are generally considered a symbol of wealth and farmers with large livestock herd sizes tend to focus more on their livestock operations and pay less attention to their land conservation.

Increasing dependence on non-farm activities reduce the economic significance of soil erosion.This is because involvement in non-farm activities consume out resource (time, labor) requiredfor installing and maintaining the conservation measures. Habtamu (2006) found negative relation between proportion of non-farm and adoption of soil and water conservation measures. Nevertheless, Mekonnen (2007) and Seid (2009) found that non-farm activities do not have influence on household's decision to invest in conservation measures

Availability of household labor is the other important variable which in most cases has an effect on household's decision to adopt new technologies. Several studies reported the positive effect of household labor availability on adoption of improved agricultural technologies. For instance, Million and Belay (2004) in their study on factors influencing adoption of soil conservation measures in southern Ethiopia found positive effect of household's labor availability on adoption of soil conservation measures. Similarly, Tesfaye (2009) in his study indicated that availability of household labor has positive and significant influence on upland rice seed production.

Contrary to this, the negative effect of larger family size household is draw labor away from investment in conservation for search of food for survival (Abera, 2003

2.2.4 The institutional factors

Institutional factors in the context of this study include support provided by various institutions and organizations to enhance the use and maintain of improved technologies such as extension, land source and land tenure system. Extension provides farmers with information related to agricultural technologies. Participation of farmers in extension events like involvement in hosting on-farm trials or demonstration and related training improves their consciousness on improved agricultural technologies and enhances adoption and sustainability. In this line, Kebede (2006) and Minyahel (2007) reported that participation on farm demonstration and attendance of training conducted positively to farmers' adoption decision.

Aziz (2007) in his study of analysis of determinants of adoption of rain water technology in Lamfuro Woreda found that farmers' participation in demonstration had positive and significant relationship

with adoption. Distance of farm plot from farmers' residence usually affected the adoption of improved technology negatively. Households near the farm plot tend to have easier to follow the activity closely. A study by Habtamu (2006) showed that distance of plot from resident was one of the significant variables explaining the adoption of soil conservation and water conservation technology negatively. In addition Ebrahim (2006) on his study on the adoption of dairy innovations in Adami Tulu found negative and significant relationship between adoption and distance from resident.

Extension services and information: Agricultural and rural development in Ethiopia, although claiming that it includes people's participation, remains only delivery-oriented in terms of its extension service rather than encouraging farmers' innovations. Extension systems formulate and promote 'on-the-shelf package technologies that result from past research. The overall organizational framework of the system is designed on the basis of a locally developed extension approach called the Participatory Demonstration and Training Extension System (Tesfaye, 1999),
but much is still desired on the technical side, methodological shortcomings leads to the limited success of the largest conservation programs in Ethiopia over the last few decades and even today. Farmers seek to reduce uncertainty about conservation innovations through information.
Farmers who know nothing about a practice cannot be expected to adopt it unless they understand its expected costs and benefits. Accurate and timely information has a positive impact on farmers' conservation adoption decision. More informed farmers better assess the impact of soil erosion on long-term productivity of their farmland and adopt practices that help resolve the problem of soil degradation (Fikru, 2009). The study conducted in Ethiopia indicated that if a farmer receives better information and advice from extension agents, the farmer will be willing to construct new conservation measures and to maintain the existing installed conservations (Wagayehu and Lars,2003).

Land tenure: land tenure security influences farmers' decision to adopt conservation measures by influencing the length of farmers' planning horizon and sense of responsibility in which farmers will not be interested to invest in soil conservation measures when the land tenure is too insecure so that the benefits of soil conservation may not accrue to them. The study made in 19 different parts of Ethiopia attributed the low level of success of natural resource conservation due to land tenure insecurity (Yeraswork, 2000; Woldeamlak, 2003; Wagayehu and Lars 2003;Bekele, 1998) and they found the negative association between land tenure insecurity and farmers decision to retain conservation structures on their fields. Since stable land tenure is very important for adoption of

major investments especially terrace construction the low level of retaining conservation structure throughout the country is attributable to land tenure insecurity.

On the contrary to the above findings, Geoffrey (2004) in his study in Zambia and Tesfu (2011) in his study in Habru district, Northern Ethiopia found no association between adopting conservation measures and land tenure security.

Incentives: Incentive for SWC is mostly stimulated in the form of food-for-work programs in the previous years even today through productive safety net programs in selected district of the country. The most crucial issue to be considered before deploying incentives, however, is acceptability of the new practices in the face of the evaluative frames of reference of farmers envisaged in the incentive. The reason for this condition is that the farmers are expected to continue the new practice after the phasing out of the incentive. That means that the incentive was deployed merely to overcome risk-aversion by farmers and to increase their relative advantage.

This phenomenon is termed as 'dynamic dis-equilibrium' where the use of incentives in the form of a subsidy could be considered as economically justified (Giger, 1998). Incentives can be provided in a variety of ways, including credit, subsidies, grants and infrastructure. Reij (1998) sees incentives as a triggering mechanism for the adoption of SWC technologies for example in Burkina Faso, he reported on a new initiative to provide a donkey cart for the transportation of stones, manure, water, firewood, etc. which directly or indirectly contributed to land management, instead of the expensive option such as a lorry that would not be sustainable after the project terminated. The most important issue with respect to access to credit is its link with land management; i.e. is credit used for hiring extra labor, purchasing fertilizers or other inputs ;if it is used for other purpose this incentive is done nothing for the sustainability of soil and water conservation practices. 20

Therefore, mere access to credit does not guarantee for proper land management as credit could be used for consumption. In this connection, some studies reported that increasing the amount of credit brought on a slightly to medium significant negative effect on the willingness to maintain SWC structures and they noted that such unusual results regarding credit occurred because the conservation technology was labor intensive rather than capital intensive, whereby cash constraint plays a minor role

2.2.5. The social factors

Membership and frequency of participation in different social organization is the other important variable expected to have relation with adoption and sustainable use of agricultural technology. Pande et al.(2011) indicated that people who are quick to adopt the technology may be characterized by

having active participation in many organizations. The study made by Mesele (2010) in the case of Kechema Agriculture Catchment, Adama indicated that social participation has positive and significant influence on the adoption of SWC technologies. Similarly, adoption studies conducted by Dereje (2006) and Jabessa (2008) indicated that social participation had positive and significant effect on the adoption decision of farmers. The above evidence and reviews of empirical studies indicated the importance of local and site specific studies to identify factors affecting adoption and sustainable use of SWC technologies and to generate scientific information which might be useful to policy makers to develop policies and strategies which are compatible to the local conditions to contribute to the solution of soil erosion problems and might give a clue to researchers for further research in the field and similar socio-economic and topographic conditions and help to recommend solution to the specific local problems based on the level and scope of the study.

Perception of erosion problem: In various studies farmers' perception of soil erosion and their subsequent conservation behavior has mixed results. In some studies there was no substantial relationship between soil erosion perception and farmers' conservation behavior, whereas other studies show that as there is direct links. For example, the perception of erosion was found to be important to the adoption behavior of SWC in the Enemay districts (Derjaw,2008),Philippines (Cramb,etai 1999) and at Andit Tid, Ethiopia (Bekele,1998) showed that farmers' decisions to retain conservation structures are positively and significantly related to soil erosion perceptions ,attitude towards new technology and exposure to new practices. On the contrary, Woldeamlak (2003) in his study found that in spite of high level of farmers' perception of erosion problem, the level of adoption of conservation structures was very limited. Kessler(2006) found that Perception of the problem did not influence farmers' decisions on how much to invest in soil and water conservation. Following low level of adoption of conservation structures in spite of high level of perception of soil erosion, however Woldeamlak (2003) was concluded that perception of the erosion problem is not a sufficient condition for adoption of conservation practices though it is a necessary one.

2.2.6 Technological factors

The diffusion of innovation school has always paid attention to the characteristics of innovation itself in addition to its traditional focus on the innovators in trying to determine the rate of adoption of an innovation (Rogers, 1995). The variation in rate of adoption in new soil and water conservation

technology among farmers is mainly by five attributes of the innovation or technology includes: relative advantage, compatibility, complexity, trialability, and observability.

Not only the above but also the agent-communication channels related issues affect an innovation's rate of adoption. Therefore, the five perceived attributes of technology together with the agent channels related issues determine the rate of adoption of newly introduced conservation technologies among farmers in different agro-ecosystem regions of the study area.

Like any other technology, characteristics of conservation technology also affect the farmers' decision to adopt and implement soil and water conservation practices almost in all parts of the country. From the technological characteristic point of view, farmers go into all these details based on their day-to-day observation of each technology. When they are new to the technology, their reservation may be due to complexity, observability, which also prohibits farmers' evaluation of the relative advantages and compatibility of the technology. The relative advantage issue also raises the need to incorporate SWC practices that give quick benefits to offset the side effects of the technology, with low cost and low labor demands (Renaud, et aI. 1998). So, SWC technologies also should consider side effects that increase farmers' risk of crop loss (Belay, 1992; Herweg, 1993). These side effects include: water logging, rodents, weeds, land occupied by conservation structures, obstacles to routine farm operations. These features highly reduce the adoption of SWC technologies among small farmers.

2.3 Conceptual framework.

This study generally aims at assessing the continuity of SWC practices by investigating the major Pillars of sustainability in Kuyu District. The adoption and continuity of SWC practices are influenced mainly by economic, social, institutional and biophysical factors. With respect to soil and water conservation, the first issue is the state of land degradation and the level of soil erosion; when the household feels the impact of soil erosion in its farm, it is expected to take the necessary measures and its response depends primarily on the level of farmer's perception on soil erosion. However, soil and water conservation does not fall only within the domain of personal behaviors in which one can easily do what one intends. Therefore, for the success of soil and water conservation efforts and intervention, it requires recognition of socio-economic, institutional and biophysical nature of target population and lastly to be effective and sustainable, considering and integrating of these all issues becomes a must.

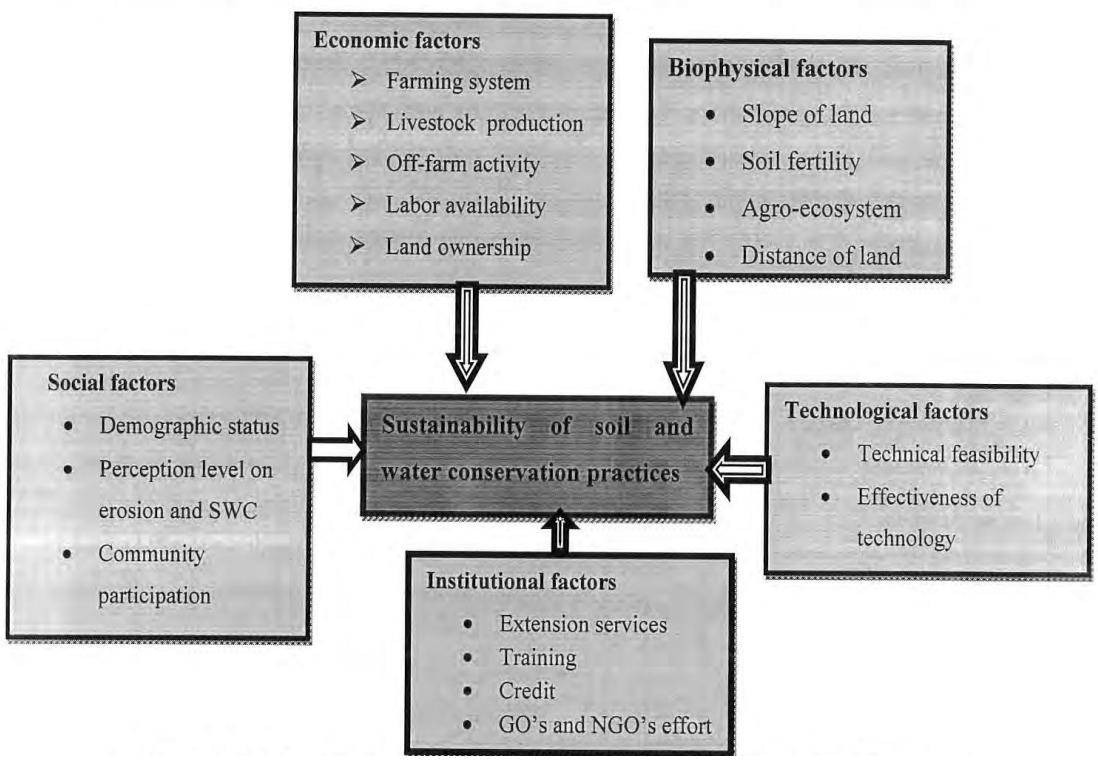


Figure 2.1: Different factors affecting the continued use of SWC practices

Source: Modified from Wubetie (2013)

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA AND RESEARCH METHODOLOGY

3.1. Description of the study area

3.1.1. Geographical Location

The study area kuyu District is found in North Shewa zone of Oromia Regional state, Ethiopia. The Woreda is located at 156 km to North West of Addis Abeba and 43 km to the capital city of the zone Fiche with the total area of 97400 hectare (974km2). The Topography of the District in the area is characterized by gorge and flat land. The highest elevation is Kesi Mountain has an altitude of 2757 masl and the lowest elevation in mugger valley which has an altitude of 1100 masl. It is bounded in south with west Shewa zone, in north Hidabu abote and Wara jarso woreda, in east Dagam woreda and in west also West shewa zone.

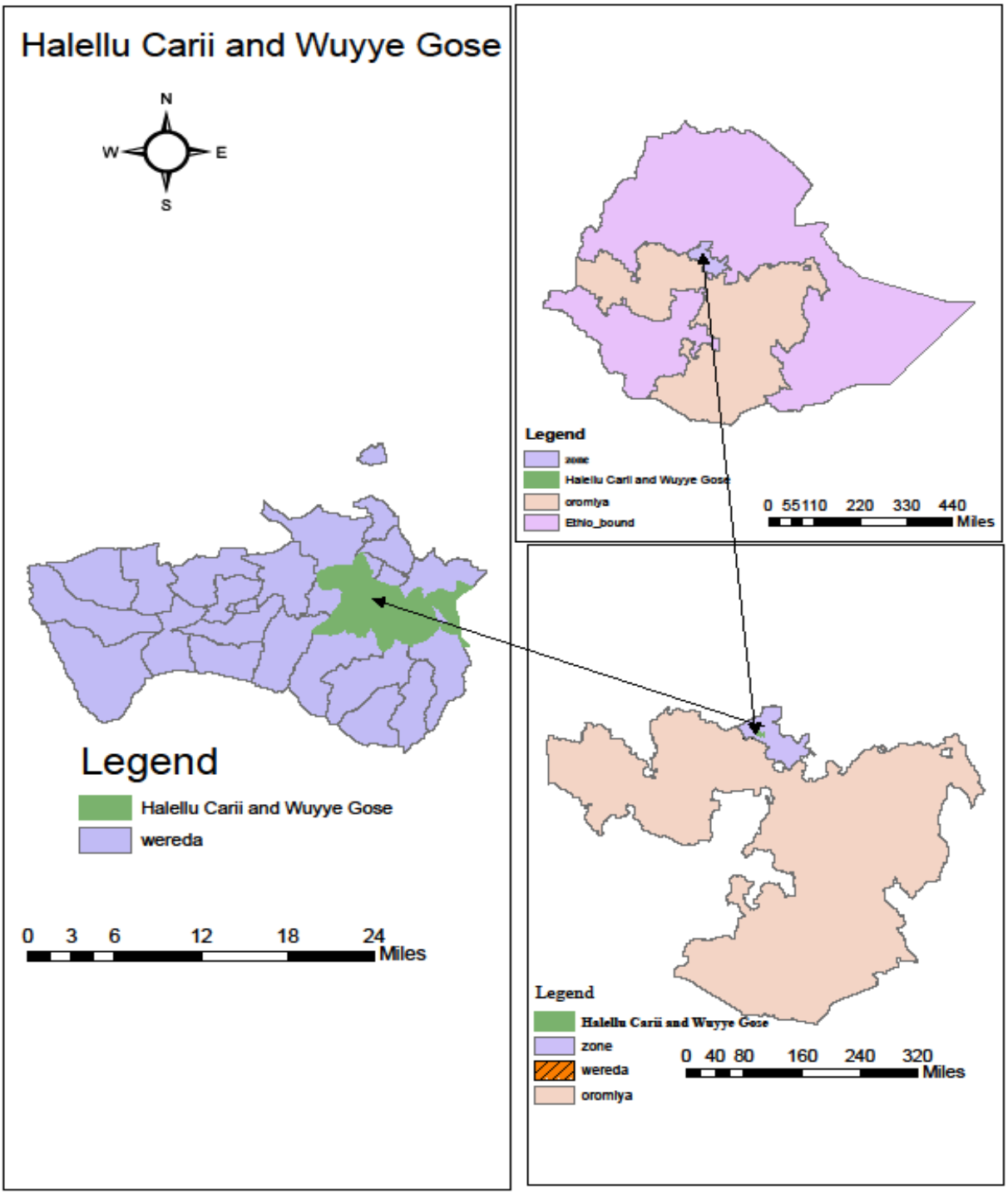


Figure 3.1: Location map of the study area (source by Researcher, 2022)

3.1.2. Climate and Vegetation cover

The study area is characterized by an average temperature that ranges from 10 ^{0}c to 22 ^{0}c and the annual mean rain fall ranges between 1600mm-1800mm, mean temperature is 16^{0}c and the rain is received during late June to early September.

The vegetation type in the Woreda is acacia species in the low lands of the surrounding Mugar valley, a little croutons and podocurpus fulcutus in the woyina daga or mid land parts and juniperous and bush types on daga or high land parts with discontinuous canopy and limited large trees in spatial cover of the District. Most parts of the woodland are interspersed with cultivated land. The cultivated landscape includes home gardens in the living quarters, small-scale nearby farms and distant farm that stretch out from the residential sites. The spatial layout in home gardens, crop fields, and adjacent areas presents a complex pattern of crop distribution.

Based on this traditional classification, the District is divided in to three major agro-ecologies such as kola 15.5%, woyena daga 50.75% and daga 33.8%.These different ecological zones alloyed for crop production and animal rearing in the production area.

3.1.3 Soil and water conservation practices in Kuyyu District

3.1.3.1 The level of erosion estimated in the area and indicators

In the study area, farmers are aware that soil degradation, in various forms, was taking place on their farms as well as in the surrounding landscapes. This is based on their perception and interpretation of indicators that reveal certain conditions regarding crop and pasture land.

Respondents of this study cited a multitude of SE on their farm and their surroundings including declining soil fertility, diminishing yield , increasing input and management requirement , presence of exposed and bare land , and proneness to flooding during rainy seasons , declining soil depth and changing soil features like texture, color, size, and water holding capacity . Farmers were requested to prioritize the most visible indicators of SE on their field. Reduced soil fertility, declining yield and gully formation were reported as the most commonly noticeable indicators of SE.

3.1.3.2 Causes of Soil Erosion

Results of the study have made clear that SE in the study area is caused by a mix of socio -economic and unwise agricultural practices, the ever growing population pressure, and cultivation of steep slopes, over cultivation, excessive rainfall, weak soil conservation practice, lack of alternative energy sources, deforestation and overgrazing are some of the causes of soil erosion reported by sample respondents.

3.1.3.3 Soil management practices implemented on each of the land use types

The traditional and improved soil management practices are practiced depend on context of land use such as uncultivated, cultivated, shrubs and pasture land types. In the other words to some extent farmers also practiced the land management particularly the traditional methods in considering the agro-ecology of the areas. At first stage Biological land management practice is one of the traditional and improved practices under taken by the local farmers in the study area. Some of the biological land management practices that practiced by the local farmers were crop rotation and grass strips.

In similar way Socio-economic survey result indicates that contour farming and minimum tillage are some common traditional physical soil management practices while soil bund ,stone bund and check dam are some among improved land management structures practiced in the study area

3.1.3.4 Soil and water conservation measures introduced and traditionally practiced in the area

The various major soil and water conservation practices which are both traditional and improved practices have been practice in the study area. In addition to the traditional practices which is considered as a culture and customs of the community the improved conservation practices was introduced before three decades and recently became the role of the everyday farmers activities in protecting soil and water loss by erosion in the area. The partners like different NGO projects and Safety Net Program in collaboration with Woreda Agricultural Development office were highly involved in practicing of biological and physical soil and water conservation measures.

3.1.3.5 Traditional and newly introduced improved SWC practices

Until recently .traditional soil and water conservation practices have often been ignored or underestimated by development agents, researchers, environmentalists and Government staff (IFAD, 1992). However surveying both traditional and improved soil and water conservation practices provides an understanding of farmers' way of thinking about the intervention (Hudson, 1992). To prevent land degradation particularly soil erosion problem the Kuyyu woreda Agricultural development office has practicing different traditional and improved soil conservation practices in the study area. These practices that used by the farmers includes soil bund ,stone bund, Hill side terrace ,cut off drain ,water way ,check dam ,grass strips ,plantation ,fallowing ,crop rotation ,contour farming ,manure application in the farm.

Crop Rotation:

Crop rotation versus mono croping farming suggests changing agro species instead of planting one and the same for many subsequent seasons .Farmers applying this soil conservation method reap numerous benefits. crop rotation helps them improve the earth structure with diverse root systems ,to mitigate pest establishments and to add nitrogen to the land with legumes known as nitrogen-fixing plants. The choice of crops to rotate is specific for each agricultural enterprise and highly depends on historical weather and productivity data. According to the result of the study the farmers practiced the crop rotation by their tradition before it is attempt to introduce as improved practices by the Woreda Agricultural Development Offices and different stalk holders that have involved and operated in the soil conservation programs. The Woreda Agricultural Development office report has showed that from total cultivated land 56616 hectares each year an average of 0.02% land size was practiced crop rotation.

Hillside terrace

A bench terrace is a conservation structure where a slope is converted into a series of steps, with a horizontal cultivated area on the step and steep risers between two steps. In Ethiopia, a bench terrace is usually developed from bunds and FanyaJuus over a period of 5–15 years through careful maintenance and buildup. Bench terraces are level along the contour in dry to moist agro ecological zones. In moist to wet agro ecological zones, they are graded to drain excess runoff sideways to the next river or waterway. Leveling the cultivated land will greatly reduce soil erosion, usually to tolerable amounts.

A hillside terraces are a structure along the contour, where trips of lands are leveled for tree planting. They help to retain runoff and sediment on steep sloping land and to accommodate tree seedlings planted on them. According to Kuyyu District Agricultural Development office the total hillside terrace constructed the last five years estimated to1792 kilometers.

Level and graded soil bunds

A level bund is an embankment along the contour, made of soil and/or stones, with a basin at its upper side. The bund reduces or stops the velocity of overland flow and consequently soil erosion. Soil which is eroded between two bunds is deposited in the basin behind the lower bund. Soil bunds reduced soil losses and runoff by 35% and 15% respectively.

Graded bunds are slightly graded sideways, with a gradient of up to 1%, towards a waterway or river. They can retain normal amounts of runoff in their basins, but they can drain excess runoff from heavy storms which would cause overflow and downslope destruction on level bunds. Most of the soil eroded between two bunds is deposited, while some will be drained sideways during heavy storms and lost from the land. However, graded bunds are more effective than level bunds in wet and moist areas with clay soils. Some studies showed that graded soil bund reduced runoff, soil and nutrient losses. Zenebe et al. [20] studied the effects of graded soil bunds on runoff and losses of soil and nutrients for 3 years (2007-2009). The results showed that Soil bund brought about significant reduction in average annual runoff (28%) and soil losses (47%). Consequently, Soil bund reduced losses of soil organic carbon (51.4%) and soil nutrients like N, P, and K by 48%, 54% &, and 47 %, respectively.

During discussions with key informants in each of the study areas, the farmers mentioned that ineffective designs by the development agents are responsible for causing gullies. Farmers use mostly soil/stone bunds that are impermeable intended to maintain all rainfall but when over topped at one location will cause gullies unless they have specially designed spillways and protected soils

below. These structures are better suited for semi-arid and arid parts of the country than in the high rainfall areas. This is in line with a study conducted by Belay (1992) in southern Ethiopia which concluded that farmers are willing to conserve their soil and water but demand more appropriate technologies, and that poorly designed practices can be the major cause of erosion in areas treated with SWC. The Kuyyu Woreda Agricultural Development office report has indicated that 8967kilometers of soil bund were constructed in all three of available agro ecology zones namely high land (Dega), mid land (Weyina dega) and low land (Kola) .



Figure 3.2 **stone** bund **constructed in the Wuyye Gosse PA** (survey photo at the field

)



Figure 3.3 soil bund during construction in Halilo Charii PA (Field survey photo at the field)

Check dam

A check dam is an obstruction wall across the bottom of a gully or a small river to reduce the velocity of the runoff and prevent deepening or widening of the gully and help to fill it up with sediment. The Potential energy is absorbed below the vertical drops of the over-fall. Sediments are deposited behind the check dams so that the slope gradient of the gully is also reduced. . The Woreda report has showed that 21,982.5 m^3 were constructed in gully area of study area.



Figure 3.4 Stone check dam construction in the watershed of the study area(survey photo at the field)



Figure 3.5. Gabion check dam construction in field of the study area (survey photo at the field)

Cut-off drain, water ways and contour farming

A cutoff drain is a channel used to collect runoff from the land above and to divert it safely to a waterway or river, thus protecting the land below from excessive erosion. The farmers construct these drains to prevent loss of seeds, fertilizers, manure and soil due to water flowing onto the plot from uphill.

A waterway is a natural or artificial channel along the steepest slope or in the valley used to accommodate runoff to be drained safely to the next river. They need to be paved with grasses or stone. Contour farming is a method of creating furrows perpendicular to the predominant field slope. It is being adopted in modern agriculture across the world for soil erosion control. The furrows retard the runoff velocity, reduce the runoff transport capacity, enhance water infilitrability, and reduce sediment transport and discharge excess runoff at non-eroding velocities. According to the FGD and key informant interview farmers highly practiced these conservation measures in the Kuyyu woreda in general and study PAs in particular by advancing the traditional methods of practicing to improved

way of conservation methods. The District Agricultural Development Office report has indicated that 3614 m^3 cut of drain and 1848 m^3 (cubic meter) artificial water way were constructed in the study area.

. **Grass strip**

A grass strip is a ribbon-like band of grass laid out on cultivated land along the contour. Grass Strips help to reduce runoff and to filter out sediments carried by runoff. They are especially suitable on soil with good infiltration on gentle slopes and where the climate is not too dry for dense grass development. Hence about 30% of farmers used in the study area from the result of interview and discussion made with key informants and District agricultural Development office have showed that 948 kilometer were planted on constructed bunds.

Fallowing

Fallowing is one of the best methods to reduce soil fertility loss (Hudson, 1992). In the study area, fallowing is restricted to highly degraded lands which cannot be restored within a short period of time. . Only 10% of the surveyed plots were fallowed. During FGD made with the farmers it was learned that through time, the traditional fallowing periods are practiced less and less as a result of the increasing population pressure and resulted in increasing cultivated land. Woreda Agricultural Development office report indicated that an average 12 percent of land is practiced fallowing from cultivated area of land every each year.

Application of manure

Application of manure was used on many of more plots than any other conservation practice,

About 70% of the total farmers applied manure near the homestead, rather than the plots of land at far distances. Based on focus group discussions and key informants interview, at current time farmers have increased the amount of manure applied because of the high price of inorganic fertilizers which the farmers cannot afford.

Plantations

Trees and other non-crop plants are planted on 40% of the surveyed plots sometimes together with other conservation practices During the transect walks, trees and other plants such as conservation and forage trees were observed to be planted along the contour in order to reduce runoff and conserve the soil and water around the root of the plants. The Woreda Agricultural Development Office report data has indicated 1521hectares of land was covered by plantation.

3.1.4. Human Population

Kuyu District has 23 rural PAS and 4 kebeles of urban , and according to the population and housing census of CSA (2007), the total population of the woreda is 173,205 of which 85,164 male and 88,041 female. Among this the rural population is (144,798) 83.6% and the Urban population is (28406) 16.4% is reside in rural and urban respectively. This shows the majority of the population lives in rural areas, depending on crop farming and livestock rearing

3.1.5. Land use and cover

The study area covers a total of land 974 km2; the land is mainly used for subsistence agriculture. The Indigenous people of study area categorize their surroundings area in to different use like cultivated land, home garden, grazing land, forest and bush land and others. The land under cultivation covers 58.13%, whereas the grazing land covers 16.76% of the woreda's land cover

Table 3.1: Land use classification by areas of land use and land cover type in Kuyu District:

Land use type	Hectare	Percent
Cultivated land……..	56616 ha	58.13%
Grazing land …….	16320ha	16.76%
Forest and bush land ……	10599 ha	10.60%
Constructions ……	7,305ha	7.5%
Others……..	6,560 ha	7.01%
Total land…….	97400ha	100%

Source: Kuyyu district agricultural development office, June 2022

3.2. Research Design

A research design is a procedural plan to be adopted by a researcher that determines the path going to be proposed to take for own research journey (Kumar, 1989).Among several designs, cross sectional research design is selected and employed for this study in order to investigate determinants that affect continued application SWC practice based on the rationale that the study had short period of time, where the data collection was carried out with one time survey. According to Kumar (1989), cross sectional study design is best suited to studies aimed at finding out the prevalence of phenomenon, problem, situation, attitude or issue by taking a cross section of the population. It incorporates both

quantitative and qualitative approaches and is useful in obtaining an overall picture as it stands at the time of study (Kumar, 1989).

3.3. Type and source of data collection

For this study both primary and secondary data sources were collected and employed. Primary data was obtained directly through the interview by using sample house hold survey as the unit of analysis, focus group discussion, key informant interview and direct personal observation .To enrich the primary data, the secondary data sources was also collected from the published and unpublished documents of the District Administration office, Environmental protection Authority of Oromia regional state and various reports, books, published researches and other related source

3.4. Sampling techniques and sample size

Both purposive and random sampling techniques were used as needed in this study. According to Kumar (2011), purposive or judgment sampling is used to provide the best information about the objectives of the study and also to describe a phenomenon about something for that only a little information is known. Regarding random or probability sampling, each element has equal chance to be chosen as a sample in the population, which means in sampling, the choice of one element is not dependent on the choice of the other element (Kumar, 1989)

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In first stage both probability and non-probability sampling techniques were used to select the study area, sample PAs and sample respondents. At the first stage Kuyu district which is one of central highlands of Ethiopia and is very vulnerable to erosion and practiced SWC measures was selected purposely depending on personal familiarity of the investigator and the land degradation problem in the area is high and is one among challenges for improving food security in the area

In this study, out of the total of 23 rural kebeles of the woreda, 2 of them were selected purposively to conduct the study based on infrastructural accessibility, high maintenance intensity, time, and other physical factors. In the second stage stratified random sampling method was employed to identify sample house holds for inclusion in the study .To these effect total households in each kebele was obtained from District .Agricultural development and environmental protection office and similarly list of participant households also identified. The house hold in the area was categorized in to two strata. That is maintained households and not maintained households in soil and water conservation practiced villages. The respondents were selected randomly by proportionate their number from both maintained and not maintained sides of households living in the purposively selected Kebeles of the woreda

The researcher used simple random sampling in order to remove bias and to get precise information.

The purposively selected kebeles were Halilo Charii and Wuyye Gosse. According to the woreda's administration office data (2022), the total households of Halilo Charii kebele is 890 of which 775 are males and 115 are females while Wuyye Gosse kebele has a total households of 1273 of which 1165 are males and 108 are females.

The total number of households under each category was used as the sampling frame and the total of 344 sample respondent's. .Sample households from each category was drawn randomly and distributed between each sample villages in selected kebeles based on probability proportional to size.

3.5. Sample Size Determination

There are several approaches to determine sample size. These include using census for small population that is to use the entire population as samples, limiting sample size of similar studies using published tables and applying formulas to calculate sample size. Several formulas were developed to determine sample size .In this study the simplified formula to calculate the sample size which was provided by Yemane (1967) was used.

It is stated as follows

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

Where n is sample size, N is population size and e is the level of precision. Thus following Yemane (1967) to determine the sample size at 95% confidence level, degree of variability = 0.5 and 9% level of precision.

Accordingly n=2463/1+2463$(0.05)^2$ =-344 sample size of farm house holds was selected and included in the sample. Because the total HHs for each of selected PAs namely Wuyye Gosse and Halilo charii were 1273 and 890 respectively.

3.6. Data collection Methods and instruments

The qualitative and quantitative data collection methods were used to investigate the issue in detail. The main reason behind of using qualitative method of data collection is that it helps to gain an understanding of underlying opinions, reasons, and also provides insights into the problem. Whereas the reason of using quantitative method is that it allows for meaningful comparison of responses across participants and study sites (Gill et at., 2008

1. Household survey Questionnaires

Primary data was collected from sampled households through a household survey. It was a method of data collection that was conducted with an open framework that allowed focused,conversational, two-way communication (Tedros, 2014). The household survey questionnaires were conducted to gather relevant information about the research. The data collectors read the questionnaires to households for those who cannot read them to collect the required data.

A household survey was administered to 339 households. It was collected by enumerators and the

researcher. The enumerators were trained on how to use the interview schedule and how to approach farmers during the interview. So as to revise and modify the schedule for the final survey, a pre-test of the interview schedule was conducted on selected respondents who were assumed to be representative of the sampled households that lived in Kebeles. Based on the feedback obtained from the pre-test, the household survey was customized in a way that the respondents could easily understand and respond to it. Household survey questionnaires were administered to help describe the demographic, socio-economic, institutional, biophysical and determinants of continued use of SWC measures of the study population.

2. Focus group discussions (FGD)

A focus group discussion is a data collection procedure in the form of a carefully planned group discussion among about six to ten people plus a moderator and observer, in order to obtain diverse ideas and perceptions on a topic of interest in a relaxed, permissive environment that fosters the expression of different points of view with no pressure for consensus (USAID, 2006). Focus group discussion is helpful mainly because group dialogue tends to generate rich information, as participants' insights tend to " trigger" the sharing of others' personal experiences and perspectives in a way that can more easily or readily tease out the nuances and tensions of complex topics and subjects, a dynamic that is not present during the interview schedule.

The discussion was held among local farmers who have good knowledge of farming (older age) at each of the selected kebeles. Both males and females have an equal proportion in group formation. Focus group discussions were held within five groups, each containing eight members, for a total of five (4*8 = 32) participants. This implies that the size of the groups was set at eight individuals in each of the four groups in order to assure that all individuals participate and that each participant has enough time to speak for each FGD. Four focus group discussions were held at the kebele level to get deep information. Thus, eight household head farmers in each kebele were participating, and each FGD was taken from 2:00–3:00 hours. The principal researcher conducted the focus group discussion, and the two supervisors were also involved as note-takers and recruiters of focus group discussants. It also helped to reduce dominance within groups and reduce the tendency for side conversations between respondents.

3. Key informant interview

Key informant interviews are a qualitative method of data collection in which in-depth interviews are conducted with people who know what is going on in the communities. The purpose of key interviews is to collect information from a wide range of people, including professionals or residents,

who have firsthand knowledge about the determinants of continued use of SWC structures in the study area. Kuyyu district Environmental protection experts, development agents, and supervisors who have environmental conservation backgrounds were involved as key informants. A total of eight key informants participated. This technique enables the researcher to explore what they know or think about the research problem that the questions cover, and then to verify, confirm, and add depth to the results of the household survey. The data was collected using a checklist.

4. Personal Observation

Personal observations were conducted to complement data collected through a household survey questionnaire with the purpose of triangulating data generated through quantitative methods. The observation method is the most commonly used technique for collecting data, and the main advantage of this method is that subjective bias is eliminated and the information obtained under this method relates to what is currently happening by watching behavior, and events, or noting physical characteristics in their natural setting.

Thus, this technique was carried out through personal observation in the field by preparing a checklist that was designed to generate data about the condition of the study area. Accordingly, the six sampled rural households SWC practices were observed purposefully.

3.7. Method of data analysis

After collection the data through different methods, analysis was made using both quantitative and qualitative methods to address the research objective. The study employed qualitative method to analyze the data gathered through FGDs, observation and key informant interviews. That means the qualitative data were analyzed using content analysis whereas for quantitative data descriptive statistics was carried out using descriptive statistics such as testing statistical level of T-value and chi-square, frequency, mean and percentages to analyze the socio-economic characteristics of the respondents, for their use and maintenance level & perception on soil and water conservation practices.

In this study logit model was used and treated against potential variables that are assumed to determine farmer's decision to maintain SWC technologies and, tobit estimation sufficiently provides the needed information on the probability and intensity as well maintenance level of soil bund, stone bund and hill side terrace types of SWC measures

3.8. Model specification

Farm households in the study area differ in the proportion of cultivated land on which different types of soil and water conservation structures were used. There are non-users of these improved and traditional soil and water conservation (SWC) measures even in the places where they are promoted. Because some households are non-adopters of SWC practices, the reported Proportion of land with SWC for such households is equal to zero. As noted in Greene (2000), a dependent variable that has a zero value for a significant fraction of the observations requires a censored regression model (also referred to as a Tobit model) because standard OLS (ordinary least squares) regression "fails to account for the qualitative difference between limit(zero) and non-limit (continuous) observations."

Thus, analysis of the determinants of the continued use of SWC requires the application of a censored regression model. Censored regression is preferred because it uses data at the limit as well as those above the limit to estimate regression. Following Maddala (1997), the Tobit model can be derived based on defining a new random variable y* that is a function of a vector of variables x as:

$Yi^{*}=\beta ixi + \mathbf{\Sigma}i,$

Yi=0 ifyi* ≤ 0,
Yi=0 if y*I > 0

Where yi is the observed (limited, censored) dependent variable,
Yi* is a latent variable that is not directly observable,
Xi is a vector factors affecting
Y*, is a vector of unknown parameters,
Bi is residuals that are assumed to be independently and normally distributed with mean
Zero and constant variance,

The above model follows many previous analyses (Amemiya, 1985) in that it distributed.

Logistic regression model is` widely applied statistical tool to study farmers' perception conservation technologies (Shiferaw, 1998; Neupane et al., 2002). Logistic regression allows predicting a discrete outcome from a set of variables that may be continuous, discrete, and dichotomous or a combination of them. The dependent variable, (i.e., decision of farmers on maintaining soil and water conservation practices) dichotomous discrete variable that is generated from the questionnaire survey as assumes censoring at 0 (although other values are possible) and that the error terms are normally a binary response, and the independent variables are a mixture of discrete and continuous.

The independent variables of the study are those which are expected to have association with farmers' decision to maintain conservation practices regularly . More precisely, the findings of past studies on the farmers' perception, the existing theoretical explanations, and the researcher's knowledge of the farming systems of the study area were used to select explanatory variables. The dependent variable is a binary response, commonly coded as 0 or 1 variable. The decision /choice is whether or not to have, do, use, or maintain

Following Greene (2008) and Liao (1994) the functional form of binary logit model is specified as follows:

$Y^*=\epsilon_{\beta}X+\epsilon$

Y*= is unobserved and thus can be thought of as the underlying tendency of an observed Phenomenon

Ɛ=we assume it follows a certain symmetric distribution with zero mean such as
Normal or logistic distribution . What we do observe is

$$y = 1 \text{ if } y \leq \mu\ 1(=0)$$
$$y = 2 \text{ if } \mu 1 < y^* \leq \mu 2$$
$$y=3 \text{ if } \mu 2 < y^* \leq \mu 3$$
$$y = j \text{ if } \mu j\text{-}1 < y^*$$

Where y is observed in j number of ordered categories, µs were threshold parameters separating the adjacent categories to be estimated with ßs.

The general form for the probability that the observed y falls into category j and the µs and the ßs are to be estimated with an ordinal logit model is

$Prob(y=j)=1-L(uj-1-\mathbf{\Sigma}\text{-}1x_{\beta}kx)$

Where L represents cumulative logistic distribution so the above binary logit model was used and Treated against potential variables that are assumed to determine farmers' decision on the adoption of PSWC technologies. All analysis was done after the coded responses to the questions entered in to the computer and the final analysis was done using STATA software.

3.9. Definition of variables and working hypotheses

. **Dependent variable:** The dependent variable for this study has dichotomous nature representing the preferred status of the farmers' decision to maintain conservation structures regularly and maintenance ratio of soil bund, stone bund and hill side terrace types of SWC measures. The variable takes the value 1 if the farmer is maintaining soil conservation structures regularly and 0 other wise and continues nature limit (zero) and unlimited (continuous) for three types of SWC measures. Otherwise If maintains SWC practices, how many practices of soil bund, stone bund and hill side terrace to maintain on how much land that measured in meter. This indicates respondent farmer's practical decision and intensity of maintenance of improved soil and water conservation practices. Both of these components of dependent variables are, therefore assumed to be influenced by a number of factors that are related to a farmer's objectives and constraints which are stated below.

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Independent variables: Based on theoretical background and empirical results of different studies on soil and water conservation activities, and other related natural resources conservation decision studies carried out in Ethiopia or elsewhere as well as considering the information from the informal survey and the researcher's knowledge of the conservation practices of the study area, the following variables are hypothesized to influence farmers' decision to maintain conservation structures on their fields that was already constructed by public campaign.

Sex of household head: This is a dummy variable which takes a value of 1 for male and 0 for female respondents. Literature indicates that female-headed households have less access to improved technologies, land and extension than male-headed households (Green, 1993). Therefore, it is expected that the male-headed households have better decision power to use introduced soil and water conservation technologies than female headed households.

Household head age: According to most of the previous studies, as age of a household head Increases, he/she becomes reluctant to retain conservation structures at most. But some studies Indicate that the old farmers use more soil conservation structure than younger farmers since Younger farmers have small plots of land and they consider as lost of land in using of conservation structure. Hence, in this study it is hypothesized that age and decision to use and retain conservation structures to be correlated negatively.

Household size: This is number of household members living together. The influence of household size may go either way. As maintaining soil conservation structure is labor intensive, if household labor is the only source of labor, households with larger household size make decision to retain structures. On the contrary, in the families with large number of mouth to feed, most of household members can be engaged in other income generating activities and hence fail to make decision to maintain and retain conservation structures.

Educational level of the household head: This is educational attainment level of the household head. It is expected that those farmers with better educational attainment perceive the problem better and make decision to retain conservation structures. Thus, education level is hypothesized to influence decision of farming households to maintain conservation structures positively and significantly.

Farm size: This refers to total area of land a household cultivates measured in ha. Farmers having large farm size can bear risk of loss of cultivation land from conservation structures and hence expected to influence adoption of structures positively.

Source of land (land ownership): this is a dummy variable representing means by which a farmer accessed land (whether rented or owned). Farmers that rented land have short term planning horizon compared to those that own the land and hence may not be interested on long term benefit that can be obtained from conservation structures. Following this, it is hypothesized that source of land (owning land) is correlated to adoption decision positively.

Slope of the cultivation land: This is slope category of cultivation field according to how farmers in the study area categorize slope of the cultivation land. Soil erosion becomes intensified with increasing slope of the cultivation land and since farmers are more perceived the problem they are more likely to use conservation measures. Hence, it is expected that slope influences farmers ' decision to retain conservation structures positively.

Perception of soil erosion: This is the degree of severity of soil erosion problem as perceived

and rated by the local people. Most of previous studies indicated that perceiving the economic Significance of soil erosion is a necessary condition and related positively with the decision of continued use of soil conservation structure. In this study it is also hypothesized to influence farmers' decision to retain conservation structures positively.

Participation in SWC works: It is a dummy variable that takes a value of 1 if households Participate voluntarily and 0, otherwise. Thus it is hypothesized that this variable influences the decision to use and maintaining those of improved SWC technologies positively and significantly.

Effectiveness of SWC technologies: Most farmers in Ethiopia use traditional conservation measures such as furrows and diversion ditches. Previous research indicated that perception of the role of technology influences adoption decision. Hence, positive association is expected between technology attributes (retaining soil erosion and ensuring crop productivity) and decision to retain conservation structures.

Off-farm activities (off-farm): This is a dummy variable representing whether the household has involved in off-farm activities or not. Involvement in off-farm activities crowds out resources required to construct and maintain conservation structures. Therefore, negative association is expected between involvement in off-farm activities and activities of conservation structures.

Contact with development agents: This is a frequency of contact between extension agents and farming households within a month. It was measured by number of contacts within a month; therefore, if the DA visits a farmer in every week, they perceive that a farmer has very good contact with the DA whereas those that are not visited well have poor contact. Households that have better contact and relation can have access to timely and adequate information and hence expected to correlate with conservation structure adoption decision positively and significantly.

Access to credit: It is a dummy variable, which takes a value of 1 if the farm household had access to credit and 0 otherwise. Access to credit is expected to have positive impact on adoption of introduced conservation measures, because if farmers get credit service their purchasing power increases and they can buy fertilizer even if its price is high and similarly can constructed and maintained via obtaining material required like hammer through purchase by the startup credit they earned..

Table 3.2. Summary for dependent and independent variables

Variables	Description of variables
Dependent variable	Decision to maintain SWC measures and it is dummy1 if maintain 0,if not maintain
Dependent variable	Soil bund, stone bund and hill side terrace SWC measures maintained in meter per previously constructed the last 5 years or the ratio and is continuous variable
Explanatory variables	
AGE	Age of house hold is continuous explained in years
HHSEX	House hold sex is dummy1 if male 0,if female
MSHH	Marital status of the household head is dummy married, not married, and divorced
FAMISIZ	Family size is continuous explained in number
HHEDU	Education level of household head is categorical illiterate, read and write, primary school, secondary school and degree
YPM HH	Year of plot management of the household is continuous measured in years
DFHO	Distance of farm from home is continuous explained in minutes
LHSIZ	Land holding size is continuous measured in hectare
SOTYP	Soil type red, clay, sandy, black and loam is dummy variables
SOPLO	Source of plot is dummy explained in type of inherited, received from kebele, rented in and shared in
OFFACT	Off farm activity is dummy explained in participated and not participated
AGEXT	Agricultural extension contact is dummy explained with yes and no
CRDACSS	Credit access is dummy explained with yes and no
SLOPE	Slope is dummy explained in flat ,gentle, steep slope
PLOFE	Plot fertility is dummy explained in high, medium and low
DEGERO	Degree of erosion is dummy explained in high, medium and low

CHAPTER FOUR: RESULT AND DISCUSSION

From the 339 sample respondents 250 reported that they were maintained the soil and water conservation measure while the 89 respondents were not maintained or removed the improved soil conservation structure. Even though the majority of respondents were decided to use the degree of maintenance differs widely between households. The analysis has two parts which are descriptive analysis result section includes demographic, socio-economic, institutional and biophysical characteristics discussion and description with their influence on continue use of SWC technologies whereas the econometric analysis part discuss on the independent variables that supposed to influence on maintenance and decision to use the improved SWC practices.

4.1 Demographic and socio-economic characteristics of households

The demographic and socio-economic characteristics such as age, sex, marital status, and family size, education level of households, land holding size and livestock number were assessed to indicate their effect on continued use of SWC measures. As shown on table 4.3.2 listed under discussion of descriptive analysis males are predominant household heads (78.4%) while female house hold accounts 21.6% respondents in the study area. Out of 73 female headed households 15.2% were maintained while the majority 40% were not maintained the SWC practices. During discussion of FGD made with including women headed households the main reason identified why they are not properly and sufficiently involved in continued use of SWC activities are due to limited access to information and other traditional social barriers particularly limited women's resources, home activities and responsibilities which include food processing, child care, weeding, harvesting and fetching water from long distances.

Regarding family size 3 age groups were identified see table 4.3.3. This indicated with the age below 15 years, between 15-64 years and above 64 years. In most Ethiopian rural areas, the main sources of labor are the family members, including wife and children. The sample households are characterized by high proportion of young population below 15 years and between 15-64 years and low number of old age person (> 64 years). In general, there are more young people than older people; because of poor health care People die at a relatively young age. The average family size is estimated to 5.86 which the variation ranges from 2 to 10 per households. When compared to the national statistics estimation of average household family size of 4.91 nationwide (CSA and ICF, 2016) the study District is one which is endowed with large family size per household.

In similar way age of households head are characterized four age groups which are identified below see table 4.3.1: This is expressed as 34.5% between 20-40 years, 44.8% between 41-55 years, 14.4% between 56-70 years while 6.1% is greater than 70 years. Most of the household heads are between the ages of 20-55 years group. The farmers within this age group are assumed to have good understanding on problem of soil erosion and advantage of SWC measures due to access to information. The mean age was 43.5 and 8.2 standard deviation for the respondents that maintained SWC practices whereas 44.012 mean and 10.2 standard deviation for not maintained households. Hence this likely indicated that the households with low age are more probable assumed to maintain SWC technologies in compared to higher ages respondent households.

The education level of respondents estimated to 24.5% were illiterate who are unable to read and write the others read and write, primary school, secondary school and degree level were 43.1%, 21.5%, 7.9% and 2.8% of respondents respectively (table 4.3.4). The result of this study are nearly in accord with those of Wang (2016),which revealed that farmers had higher ages and lower education level in developing countries. This also coincides with studies conducted in Ethiopia by (Ashenafi, 2006; Meskerem,2011).

In the same way concerning land holding size more than half which are 54.7% respondents owned less than 2 hectare. The average land holding size for the respondents maintained the structures of SWC are 2.6 while for not maintained households are 2.01 see table 4.3.5. In the other words when regard to marital status the respondents that accounts 1.2% were single while married and divorced households are 80.8 % and 18% respectively. Similarly regarding Livestock Production the type and total number of livestock owned across all sample households is given in Table 4.3.10 listed under descriptive analysis .The respondent farmers rear livestock for various purposes, including draught power, milk, meat, eggs, transport and other purposes. The main sources of feed for livestock that commonly practiced in the study area are crop straw, hay, and pasture or grazing land and rarely leaf of certain plants.

4.2 Perception of respondents on soil erosion and conservation measures:

Perception of soil erosion is a hazard to agricultural production and sustainable agriculture is the important efforts at construction and maintenance of conservation measures. In theory the farmers who perceive soil erosion as a problem having negative impact on productivity and who expect

positive returns from conservation are likely to decide in favor of adopting available conservation technologies (Semgalawe and Folmer,2000;Geberemedinand Swinton,2003).

Of total respondents perception 53.2% think that the major causes of soil erosion is by the slope of land to be being steep , 19.1% is believed as rain fall being too much or heavy ,1.2% is assumed as runoff from up slope area, 17.6% is perceived as the cause was soil being too erodible while 7.1% due to different cases.

The findings were able to indicate that the major cause of soil erosion is mainly by the slope of land being steep. But It was in contrary with the finding in the Debre mewi watershed by Tigist (2009) in which gully erosion in the overgrazed area was the source of most of soil loss . However the finding is consistent with common beliefs or prior hypothesis that steep slope is the main cause of soil erosion.

As outcome of findings revealed of the total sample households the majority 86.4% of the respondents was believed the erosion problem and had understood different causes of erosion but in contrary only 250 households were decided to maintain while the other 89 respondents were not implemented maintenance work on conservation structure in the study area from total respondents. This evidence ensured that perception is not always a guarantee to the use of improved technologies of soil conservation. The similar result was reported by Beweket (2001), that the majority of the farmers had indicated soil erosion as an important agricultural problem, yet the majority again was not willingly participated in construction of different types of bunds. In addition In the study of Tegene (1992) which is in southern Ethiopia reported that the majority of the farmers were well aware of the problem of soil erosion but they were less willingness to utilize the introduced technologies

4.3 Descriptive analysis

4.3.1 Age

The age of the households was hypothesized to have as one factor that has influence on farmers ‘continue use and maintenance of SWC technologies. From table 4.1 shown below mean and standard deviation of household’s who maintained SWC regularly were 43.5 and 8.2 while for households who did not maintained or either removed were 44.012 and 10.2 respectively.

The average age of households who maintained was smaller than those removed or either not maintained. Hence the result of the analysis could indicate that younger households are more early adopter than old age because majority are enabled to maintain regularly than others. The t-test statistical analysis indicated that mean age of the two groups are significant at 1% significance level

Table 4.3.1: Distribution age by sample households

Age group	Maintain regularly (HHs=250)		Not regularly maintain(HHs=89)		Total sample HHs (HHs=339)		T-value
	Frequency	%	Frequency	%	Frequency	%	9.747
20-40	98	39.2	19	21.5	117	34.5	
41-55	130	52	22	24.6	152	44.8	
56-70	16	6.4	33	36.9	49	14.4	
>70	6	2.4	15	16.9	21	6.1	
Mean	43.5		44.01		44.41		
SD	8.2		10.2		9.244		

Source: own survey, 2022

4.3.2 Sex: The survey result has shown that from total respondents 78.4 % were male-headed households whereas the other remaining 21.6 % were accounts female-headed households. As the result of analysis, it is observed that the chi-square test for the sex is significant at 1% level between female and male headed HHs that coincide with prior expectation to decide the continue use and maintenance of SWC technologies. From observation of analysis male-headed households were more likely need to maintain than female- headed. The concrete evidences concluded are male headed HHs are relatively involved in the community participation during newly constructed soil and water conservation activities and have exposure to the new ideas and innovation generated from or provided by different sources including Development agents and NGO about improved technologies and conservation of environment . In the other words the male households have more control over the land resources owned by family member than female headed so that the findings result is in consistent or in line with the hypothesis.

Table 4.3.2: Distribution of sample households by Sex

Sex of the respondents	Who maintained (HHs=250)		Not maintained or Removed (HHs=89)		Total sample HHs (HH=339)		X^2 (chi-square)
	Frequency	%	Frequency	%	Frequency	%	16.605***
Male	212	84.8	54	60	266	78.4	
Female	38	15.2	35	40	73	21.6	

*** Significant at 1% level

Source: own survey, 2022

4.3.3 Family Size of surveyed Households:

As shown below on Table 4.3.3 the size of family members were explained as that the male and female below 15 Years were 262 and 294,male and female between 15-64 yeas were 335 and 337 while male and female above 64 years were 32 and 26 respectively. The family size ranges from 2 to 10 in number.

Table 4.3.3: Age distribution of household family members

Description	Below 15 years		Between 15-64 years		Above 64 years		Total;
	No	%	No	%	No	%	
Male	262	77.1	335	98.5	32	9.4	
Female	294	86.5	337	99.1	26	7.6	

Source: own survey, 2022

Family of sample HHs has a mean of 6.14 and standard deviation of 1.76 for household head that were maintained whereas 5.6 mean and 1.74 standard deviation for not worked maintenance or either removed of physical soil conservation structures. Prior expectation for family size of HHs are assumed as those households with more numbers of family have sufficient labor force and will decide to use and maintain SWC works in the study area than with low number of families .

However the survey result shows that the mean difference between the two groups has shown no significant association and therefore insignificant with t-value of .545.This was in line with study conducted in Ethiopia by Yazie (2013) large family with great number of mouth to feed, immediate food need is given priority and labor is diverted to off-farm activities that generate food.

4.3.4 Educational level of sample households

In the expectation the level of education of households head is hypothesized to have more influences on the respondents in the study area regarding the use and maintenance of SWC works. Due to that as the households education level increases the awareness and knowledge on the merit and importance of the SWC technologies are enhanced and skill on construction of physical soil conservation structures relatively improved and understandable so that highly contributed to the adoption ,continue use and maintenance of SWC structures which is part and an element of environmental conservation.

Concerning the educational level of sample households heads the survey result indicated that about- 24.5 % of total respondents were illiterate 43.1% read and write 21.5 % Primary school 7.9 % secondary school while the other 2.8 % were BSC.

As shown in table 4.3.4 among farmers those maintained regularly were 26.8 %, illiterate 41.2 % read and write 20.8% p primary school and while remaining were secondary to degree level. From not maintained group of households the number of Illiterate accounts 15.3% read and write 50.7% primary school 24.6% while the rest are Secondary school and above.

The result of analysis indicated that it is coincides with the prior hypothesis which assumed the higher the level of education of the households the more the respondents decided to use and maintain the SWC technologies.

The result of chi-square(x^2) test has found to be significance difference for distribution of illiterate and literate household heads between two groups at 5 % significance level.

Table 4.3.4: Distribution of Educational status by sample HHs.

Educational level	Maintain regularly (HH=250)		Not maintain or either removed(HH=89)		Total sample HHs(HHs=339)		X^2
	Frequency	%	Frequency	%	Frequency	%	6.217**

Illiterate	67	26.8	14	15.3	81	24	
Read and write	103	41.2	45	50.7	148	43.6	
Primary school	52	20.8	22	24.6	74	21.8	
Secondary school	19	7.6	8	9.2	27	8	
Degree	9	3.6	0	0	9	2.6	

**Significant at 5 %_level

Source: own survey, 2022

4.3.5 Land size and distribution between sample households:

As shown on table 4.3.5 Land size per households in the study area was ranges from 1to 3.5 hectares. The land holding category was classified in to cultivated land, fallow land, grazing land, bush or forest land and others

The surveyed data analysis shows that the mean and standard deviation of land size for the house holds that maintained regularly were 2.6 and 10.06 while for the households those not maintained or either removed were 2.01 and .42 respectively .

This indicates that large land size owner respondents were more decide to maintain and construct SWC structures than the farmers owned small land size. The possible reason may be that the owner of small farm size has limited size and reduced their farm land if SWC works are constructed or maintained and likely such households farmers either removed or not maintained to avert the risk so that removed the physical and biological soil conservation structures competed with their cultivated land. Moreover it was also limited to have fallow and grazing land which losses opportunity to reduce soil erosion and increase soil productivity. However the t-test value or the mean difference of the two groups sample households showed insignificance relation association.

Table 4.3.5: Distribution of sample households by land holding

Farm size (hectares)	Number of farmers	% (percentage)	t-value
Up to 0.75	23	6.8	1.076
0.75___1.25	43	12.6	
1.25___2	119	35	
>2	154	45.3	

Source: own survey, 2022

4.3.6 Slopes, soil fertility, soil color and degree of erosion:

Slope is one of the physical characteristics of farm plots used as proxy measures for the degree of erosion, which in turn affects the use of improved soil conservation measures.

During the interview with respondents the slope of plots were classified in to flat (0-6%),gentle slope(6%-15%) and steep slope >15% which different soil conservation structures are recommended for reducing soil erosion .Of total plots of land 28.6% is flat whereas the others 59.6% and 11.8% were gentle slope and steep slope respectively which the later two are highly require construction and maintenance of SWC technologies.

The result of analysis shows that households owned flat plots of land that maintained SWC structures were 73 and not maintained or either removed were 16 ,gentle slope who maintained were 143 while not maintained were 67 .The other remaining households with steep slope did maintenance work were 34 and not maintained were 6 .

The finding is able to show that it is match with prior expectation which explained the respondents with steep slope and gentle slope were decided to maintain the SWC technologies relatively than with flat land that less likely adopting. The possible evidence was as farm plot of land slope increases the vulnerability of soil to the erosion is high which the consequences are seen in reducing crop productivity by losing top fertile soil. Hence forth the chi-square test showed that the slope of land on farmer's decision to use SWC works in continued manner between two groups was found to be significant at 5% level

Soil fertility: Interviewer together with the respondents classified their own farm plots in to three categories low, medium and high. The total 954 plots of land surveyed were classified in to 15.3%, 76.2% and 8.2% as high, medium and low fertility level respectively

In the hypothesis as level of soil fertility is low farmers are more motivated to improve the fertility of soil by mitigating erosion through constructing SWC structures and using inorganic and organic fertilizer that includes manure and compost application.

The analysis result indicated that the households with high soil fertility that maintained were 29 while not maintained regularly were 21 .with medium and low soil fertility level that maintained were 202 and 19 whereas 61 and 7 were not implemented maintenance of soil conservation measures. The chi-square test is 6.212 and has found to be significant at 5% level.

Soil color: In case of soil color respondents figure explained on table 4.3.6 has shown as 60.% is red ,12.6 %black,7.4%brown,11.8 % sandy and 7,9 % is clay soil.

Soil color is one of the physical characteristics of farm plots used as proxy measures for both level of fertility and degree of erosion.

In the expected hypothesis soil with red color has low fertility with high vulnerability to erosion problem while in contrary the black soil is more fertile with less erodibility characteristics. Hence the result of the analysis is in line with prior expectation which the finding has shown the level of the maintenance work of physical and biological conservation technologies made by the respondents were high with red soil color while in others color were practiced with different level. The chi-square test has shown that soil color has influences on decision and therefore has strong association with 1% significant level.

Degree of erosion problem: The degree of erosion was classified in to high, medium and low. According to sample household respondents the finding analysis was indicated the level of erosion 17%, 65% and 18% as high, medium and low level.

When the chi-square analysis is carried out the result of analysis was revealed that from the total respondents 50 HHs from high vulnerability level were maintained the SWC works while 172 from medium and 21 from low level of vulnerability. From medium and low 75 and 15 were either

removed or not regularly maintained soil conservation practices.. Therefore the chi-square was found to be significant at 1% level.

Table 4.3.6: Distribution of farm plots by category of slope, level of fertility, soil color and degree of erosion

	Description	Frequency	%	Chi-square (x^2)
Slope category	Flat (<6%)	97	28.5	6.600**
	Gentle (6-15%)	202	59.4	
	Steep slope (>15%)	40	11.8	
Fertility	low	28	8.2	6.212**
	medium	259	76.2	
	high	52	15.3	
Soil color	red	204	60	19.464***
	Black	43	12.6	
	brown	25	7.4	
	Sandy	40	11.8	
	clay	27	7.9	
Degree of erosion	low	58	17	38.130***
	medium	220	65	
	high	61	18	

Source: own survey, 2022

4.3.7 Distance between farm plots and home

Distances between farmers home and plots of land is hypothesized as crucial factors that has an impact on adoption and maintenance decision on soil conservation technologies in area of study.

As the distance of fragmented plots of farm land is increased the farmers willingness to construct, use and maintain the SWC practices will discourage so that declined. In this case farmers encountered shortage of time while in contrary have enough time for short distance plots that creates convenient situation for continued use of SWC technologies Shiferaw and Holden (1998) found that some farmers undertake SWC works during the evening, making difficult to go to field that are located far from home. In addition the far distance plots of farm land is susceptible to open grazing by livestock

during off-time after harvesting that able to creates collapse of conservation structure which highly make vulnerable and aggravates soil erosion.

The t-test was revealed that it has significant association with 10% level

Table 4.3.7: Distance between plots and farmers home

Distance of plots(in minutes)	Maintain(HHs=250)		Not maintained or removed(HHs=89)		Total sample HHs(HHs=339)		t-value
	Frequency	%	Frequency	%	Frequency	%	4.002
<25	185	74	61	68	246	72.6	
26-50	65	26	29	32	94	27.3	
>50	-	-	-	-	-	-	

Source: own survey, 2022

4.3.8 Economic and institutional characteristics of the respondents:

Agricultural development Minister in Ethiopia designed the extension system on the basis of locally developed extension approach called the participatory demonstration and training extension system (Tesfaye, 1999) but much is still full of technical and methodological short comings lead to the limited success of the largest conservation programs in Ethiopia over the last few decades and even today.

Extension service is hypothesized as crucial tools and an element of methodologies to bring change on attitudes of farmers through improving their knowledge and skill on agricultural development and environmental conservations activities in the country in general and study area in particular.

Hence forth the survey result has indicated that the farmers that have been provided agricultural extension once per month is 151 , twice per month 88 three times per month 55 ,once per three month 38 and twice per three month 7 households

The analysis has shown that the farmers with frequent contact with extension agent were decided to use and maintain SWC works in continued manner relatively than with less contact of HHs with extension service delivery agents .The chi-square test was revealed as the extension service has

influence on farmers decision and therefore the mean difference of two groups is significant at 10% level.

Access to credit: The respondents that used credit were 23.8% while not able to get access loan capital were 75.6%.The chi-test on decision of farmers was found to be significant at 10% level.

It is a dummy variable, which takes a value of 1 if the farm household had access to credit and 0 otherwise. In prior expectation access to credit is assumed to have positive impact on adoption of introduced conservation measures, because if farmers get credit service their purchasing power increases and they can buy fertilizer even if its price is high and similarly can construct and maintain via obtaining material required for SWC structures like hammer through purchase by the startup credit they earned. Therefore The Chi-square result could able to confirm or consistent with the hypothesis.

Table 4.3.8: Agriculture extension service delivery to sample households:

Institutional support		Maintain regularly (HHs=250)		Not maintained or removed (HHs=89)		Total sample HHs (339)		X^2(chi-square)
		No HHs	%	No HHs	%	No HHs	%	2.924*
Agricultural extension	Once per month	121	48.4	30	33.8	151	44.5	
	Twice per month	65	26	23	26.1	88	26	
	Three times per month	52	20.8	3	3	55	16.3	
	Once per three month	9	3.6	29	32.3	38	11.2	
	Twice per three month	3	1.2	4	4.6	7	2	

Source: own survey, 2022

4.3.9 Source of land plots:

As shown below on table 4.3.9 the sample households were responded the source of land as 48.2%were inherited, 39.4 % obtained from kebele while 5.6% were rented in and shared in from others. Accordingly this source was indicated the households that plots of land belong to them are 87% while the other 13.4% were not owned by the respondents or the lands were belongs to others. The survey analysis has shown that from sample households with their own plots of lands and made decision on maintenance work on SWC structure were 216 and not maintained were 81 while for shared in and rented in respondents 34 were carried out maintenance while the rest 8 households were not participated in conservation of environment via maintaining physical and biological soil conservation structures. The finding is proved that the farmers who owned or the plots of land belongs to them were sensing ownership character and believed that they are used throughout their life time and as well assumed as able to inherit for their children so that enabled to maintain technologies of soil conservation. .The analysis result is consistent with normal beliefs or hypothesis which therefore the chi-square test was found to be significant at 1% level.

Table 4.3.9: Land owner ship distribution

Source of plots		Maintain(HHs=250)		Not maintained(HHs=89)		Total sample HHs(HH=339)		X^2 value
		No HHs	%	No HHs	%	No HHs	%	
	Inherited	130	52	26	29.2	156	47	18.456***
	Obtained from kebele	86	34.4	55	61.5	141	40	
	Rent in	18	7.2	4	4.6	22	6.7	
	Shared in	16	6.4	4	4.6	20	6.7	

Source: own survey, 2022

4.3.10 Livestock production and management:

Livestock production is one part of mixing farming system in the study area which is the source of income, food and use of draft power .see table 4.3.10 below the number of livestock, total tropical livestock unit and average livestock unit.

In normal beliefs and prior expectation the impact of livestock production on SWC activities becomes one of the influential challenges for the sustainability of physical and biological soil conservation measures. According to the discussion made with key informants and their responses from interview the farmers used mainly open grazing rather than using control grazing that resulted in over grazing and destruction of physical and biological soil conservation technologies. Therefore the final consequences are resulted in environmental degradation which caused by soil erosion.

Hence until the farmers started to practice improved livestock husbandry and graze land management that expressed by rearing limited number of improved livestock and using zero or control grazing management the challenges arise from livestock production will continue as problem on SWC technologies by aggravating the vulnerability of environment to destruction and erosion problem.

Table 4.3.10: Total number of livestock by sample Households:

Type of livestock	Total number of livestock	Total TLU	Mean by number	No of respondents	%
Ox	310	310	2.08	310	91.2
Cow	310	310	1.91	310	91.2
Calve	275	68.75	1.81	275	80.9
Heifer	191	143.25	1.64	191	56.2
Horse	37	40.7	1.00	37	10.9
Mule	10	11	1.00	10	2.9
Donkey	105	73.5	1.25	105	30.9
Goat	50	6.5	4.24	50	14.7
Sheep	254	33.02	4.97	254	74.7
Chicken	265	3.45	5.72	265	77.9

Source: own survey, 2022

4.3.11 Off-farm economic activities on SWC practices:

One of the interest of the study was to investigate if there is a relation between farmers decision on maintaining SWC structures and involvement in off-farm income generating activities .Accordingly the majority of the respondents that maintained the conservation structure were 186 households (74.4%) that were from not involved in income generating activities while from the involved were 64 HHs (25.6 %) whereas not maintain the structure was 22HHs (24.6%) from involved and the remaining 67HH (75.3 %) was from not involved in the off-farm activities. As this result indicated as the farmers are involved or not in any of income generating activities it is more likely showed and approved the influence of off-farm activities in the decision of farmers on the maintenance practices.

But in the other words in the study of (kessler, 2006) was stated that the relationship between off-farm employment and adoption performance of SWC is poorly understood. Off-farm activities may have a negative effect on the construction and maintenance adoption behavior due to reduced labor availability.

When the farmers and their family members are more involved in off –farm employment the time they have is limited and so that discourage either to construct or maintain the SWC practices. Hence chi-statistics test was found to be different between two groups and significant at 1%level.

4.3.12 Effectiveness of improved SWC measures

As the surveying analysis has indicated from the respondents interview the level of effectiveness of SWC measures are observed at level of different scale and so that can be one element of the determinant factor that affects the constructing and maintenance work of soil and water conservation practices. See table 4.3.12 below

Table 4. 3.12: level of effectiveness of SWC practices

Types of SWC measures	Rank /level of effectiveness/				
	Least	Less	medium	More	Most
	%	%	%	%	%
Soil bund	0	7.1	56.2	14.7	20.9
Stone bund	0	2.4	2.4	56.8	38.2
Cut off drain	0	9.4	28.8	26.2	25.2
Water way	1.5	28	17.4	15.9	27.1

Planting different trees	2.1	2.1	12.1	22.4	46.5

Source: own survey, 2022

4.3.13 Technical constraints of continued use of introduced SWC measures

Regardless of a high level awareness and positive attitude towards soil erosion and soil and water conservation Practices, the level of the farmers that constructed or maintained the SWC structure on their farm land is low and below expectation. Care for the physical structures and a range of complementary conservation practices were not observed in the study area. As shown in table below, farmers were able to mention or respond the type and level of problems that caused due to intervention of different physical and biological soil and water conservation measures which attempt to be explained or stated relatively in percentage.

Table 4.3.13: Types and level of problems in relation to constructed SWC measures

Types of problems	Soil and water conservation practices				
	Soil bund	Stone bund	Cut off drain	Water way	Plantation
	In %	%	%	%	%
Source of rodents	65.9	84.4	1.2	1.2	1.2
Reduced farm land	93.8	86.2	0	0	14.1
Difficult to run ox	92.6	92.9	0	0	3.5
Labor intensive	86.5	94.4	35.6	27.1	30
Difficult to implement (technically)	85.3	94.4	52.9	50	47.9

Costly	71.8	98.2	55.6	39.7	21.8

Source: own survey, 2022

4.4 Econometric model analysis

In this study Logit and Tobit regression were employed in order to estimate the effects of the most important explanatory variables on farmers' decision to maintain SWC regularly and the ratio of soil bund, stone bund and hill side terrace maintenance per previously constructed practices. The response variable was either to maintain or not maintain SWC structures and ratio of soil bund, stone bund and hill side terrace types of SWC practices.

Before running the regression analysis pair wise correlation was conducted in order to check the existence of multicollinearity among categorical/dummy variables .The result indicated that there is no multicollinearity among each independent variables (appendix iv)

According to Maddala (1992) the correlation value of 0.75 and above indicates the strong relationships between dummy independent variables.

Accordingly there were no any variables that excluded from the model to reduce the effect of on regression estimate. The variance inflation factor (VIF) was also computed to test multicollinearity among continuous independent variables. The VIF result was found to be less than 10 and it indicated that there is no multicollinearity across continuous independent variables. (Appendix IV)

4.4.1 Logit model regression results of farmers' decision to maintain SWC measures regularly in Kuyu District.

To identify determinants affecting farmers decision to maintain SWC measures, binary logit model was employed. A binary logistic regression model was fitted to estimate the effect of hypothesized explanatory variables on the probabilities of being decided to maintain or not. The variables takes the value 1 if the farmers decide to maintain SWC measures and 0 other wise (not decide to maintain) Table 4.4.1 presents the result of logit model .Before interpreting the significant variables it is essential to determine the statistically validity of the model. Our model fitted the data reasonably well [Wald Chi-squared (28)=106.40, P=0.000].Thus, the hypothesis that all coefficient of independent variables are jointly equal to zero was rejected.

As shown in Table 4.4.1 the logit model result revealed that a total of 16 explanatory variables considered in the economic model out of which,10 variables were found to have statistically significant to affect farmers decision to maintain SWC measures regularly of a given household. These variables were include Age, marital status ,education level, family size, agricultural extension contact, off-farm activity, credit access, slope, year of plot management and degree of erosion.

Numbers of variables including land holding size, source of plot, sex, soil type, and plot fertility were not statistically significant but found to have positive effect on farmers decision on maintaining SWC practices.

Table 4.4.1. Logit model result on determinants affecting farmers' decision to maintain SWC measures

Explanatory variables	**Coef.**	**Robust Std. Err.**	**Marginal effect (dy/dx)**
AGE	-.0961***	.03470	-.0060
FAMSIZ	-1.1353***	.2756	-.0711
LHSIZE	.02522	.0217	.0015
DFHO	-.0526	.0323	-.0033
YPMHH	.0542***	.0203	.0034
HHSEX			
Female	-.2693	.7081	-.0171
MSHH			
Married	5.0427***	1.0695	.4198
Divorced	3.7288***	1.1857	.3280
HHEDU			
read and write	1.8292***	.6461	.1378
primary school	2.5028***	.7924	.1767
secondary school	3.0592***	.9844	.2044
BSC degree and above	.8593	3.6330	.0704
SOTYP			

black	.2071	.6038	.0134
loam	.8946	2.6778	.0547
sandy	2.0048	1.9221	.1110
clay	1.8392	1.3170	.1034
SOPLO			
Obtained from kebele	6645	.6054	0413
rent in/out	-.6743	1.6632	-.0367
shared in/out	-.7661	1.1875	-.0481
OFFACT			
Yes	5.0235***	1.1708	.2145
AGEXT			
yes	2.9754***	.6735	.2435
CRDACSS			
Yes	1.2425*	.6836869	.0776533
SLOPE			
Gentle slope (6-15%)	1.6400**	.7190	.0979
steep slope (> 15%)	.8908***	1.0699	.0491
PLOFE			
medium	-1.1179	.9325	-.0631
low	-1.5758	1.1392	-.0928
DEGERO			
medium	-1.8075**	.7891	-.1009
low	-5.8636***	1.1162	-.4498
_cons	-3.5891	2.6521	

logistic regression

Log pseudolikelihood = -69.697726
Number of obs = 339
Wald chi2(28) = 106.40
Prob > chi2 = 0.0000
Pseudo R2 = 0.6429

***, ** and * indicates level of significance at 1%, 5% and 10% respectively.

Reference group for dummy variables:

[a] Excluded category: male household head

[b] Excluded category: single respondent

[c] Excluded category: illiterate respondent

[d] Excluded category: red soil type

[e] Excluded category: inherited (source of plot)

[f] Excluded category: a respondents not participated in off-farm income

[g] Excluded category: a respondent who got agricultural extension service (no)

[h] Excluded category: a respondent who got credit access (no)

[i] Excluded category: flat slop (0-6%)

[j] Excluded category: high plot fertility

[k] Excluded category: high degree of erosion

Marital status: married house hold heads in marital status is of determinant with positive effect of decision to maintain SWC technology at statistically significant level (P< 0.1) .This means the married household farmers were more likely decide to maintain SWC technologies when compared to single. The model outcome indicated that married house hold head increase by 1, the probability of decision to maintain increase by 41 percent.

Education level: Education level is one of the most important determinant that the households educated up to primary school were found to have positive influence on decision to maintain SWC structures at statistically significant level (P< 0.01).The model outcome indicated that read and write, primary and secondary level educated household head increase by 1the probability of decision to maintain SWC technologies were increase by 13,17and 20 percent respectively.

This reveals that high education level of the households have a significant positive influences on farmers decision to maintain SWC technologies when compared to illiterate households. .Hence there is sufficient reasons to reject the null hypothesis that education level has no influence on farmers decision on the conservation structures and therefore It can be concluded that illiterate and less educated farmers are less likely to sustain and decide to maintain SWC structures than the better educated farmer households. As the educational level of farmers increases their likelihood to decide on maintenance of SWC technologies are increases.

This result contradicts with finding of Habtamu (2006), who found an insignificant relation between education and the adoption of new soil and water conservation technologies in Anna watershed, southern Ethiopia .Bayard et al.(2006) who found significant negative influence of educational level on farmers adoption decision of SWC technologies Haiti. But it similar with the finding of Chomsa (2004),Fikru (2004),Nkegbe(2011),pucket(2011),Tiwari et al.(2008),Abebaw et al.(2011) .It also in line with (Long,2003,Getachew,2005,darajaw,2008,Etana ,1985) were found the significant contribution of education on conservation efforts.

Family size: Number of families in the households head is one of the determinant with negative effect on decision to maintain SWC structures at statistically significant level ($p< 0.01$).The model outcome indicated that the low family size increase by 1,the probability of farmers decision to maintain SWC measures increase by 7 percent..

This reveals that as household size decreases the likelihood of decision to maintain SWC measures increases which mean the coefficient has negative sign that shown household with smaller household size seem to decide to retain conservation structures than household with larger family members.

This negative sign but the significant correlation is found to be in line with the previous studies by Wagayehu and Lars (2003),Yalegaw (2013).They found negative and significant association between adoption of SWC and household size .This might be because the large families with greater number of mouth to feed, immediate food need is given priority if labor is diverted to off-farm activities that generate income for households food consumption.

Agricultural extension contact: Agricultural extension contact found to have a positive influence on farmers decision to maintain SWC practices at statistically significant level ($P<0.01$).The model outcome indicated that household farmers with agriculture extension contact increase by 1,the probability of decision to maintain SWC structure were increase by 24 percent. .

This explained that the contact of farmers with development agent increased the probabilities of retaining SWC technologies since it gives access to information on innovations, advice on types of SWC measures and their use, and management of structures which will directly lead the farmers to increase investment in conservation.

Previous studies conducted in Ethiopia Yalegaw(2013),Wagayehu and Lars (2003) were indicated that if there is close contact with extension agent ,the farmers are more likely to receive better

information and advice from extension agents and they tend to be willing to construct new conservation measures and to maintain the existing installed conservation structures. In other cases this result is contrary to the finding of Akililu(2006) that showed agricultural extension is more focused on crops and livestock production than on SWC so that farmers having contact with extension agent tend to reduce investment in conservation.

Slope: Gentle slope (6-15%) has positive influence on decision to maintain SWC structures statistically significant level ($P<0.05$).The model outcome indicated that the gentle slope of farm plot increase by1,the probability of decision to maintain SWC measures increase by 9 percent.

This implies that farmers cultivating sloping and erosion vulnerable farm plots are retaining conservation structures better than farmers that cultivated lower sloping and less erosion vulnerable farm lands. It can be concluded that farmers were found to take SWC practices more seriously when they are cultivating steep slope ,for instance ,farmers in Konso area started a unique SWC system because their land scape is dominated by steep slopes(Tesfaye,2003)

This is consistent with other studies undertaken in different parts ofEthiopia (Bekele,1998,Wagayehu and Lars,2003; Akililu,2006,Fikiru,2008,Yalegaw,2013) were reported the positive association between slope and farmers decision to adopt and retain conservation technologies

Year of plot management : Farming experience or year of plot management found to have a positive influence on decision to maintain SWC practices at statistically significant level ($p<0.01$). The model outcome indicated that the greater the year of plot management increase by 1, probability of decision to maintain SWC measures were increase by 0.3 percent.This implies that households with more experience of farming are more likely to decide maintenance of conservation technologies than farmers with low year of plot management.

Degree of erosion: The degree of erosion with high level has positive influence on the decision to maintain SWC structures at statistically significant level ($p<0.05$).The model outcome indicated the high level of degree of erosion increase by 1, the probability of decision to maintain improved technologies of SWC were increase by 10 percent.

This implies that the higher level of erosion on the farmers farm land the more likelihood of decision to maintain SWC technologies by farmers so as to reduce soil erosion when compared to low level of erosion. .This indicates that farmers in the study area have fundamental understanding about the

problem of soil erosion and its impact on agricultural production. perception of soil erosion as problem to crop production is the most important determinant factor in adoption of SWC measures (woldeamlak,2006).Theoretically ,the farmers who perceive soil erosion as a problem having negative impacts on productivity and expect positive return from conservation are likely to decide in favor of adopting available conservation technologies (Semgalawe and Folmer ,2000;Gebremedin and Swinton,2003)

***Age* :** The result of the logit model reveals that age of household farmers was negatively and significantly affect the decision to maintain SWC measures at ($P<0.01$). The model outcome indicated that the age of household farmers decrease by 1, the probability of decision to maintain technologies of soil and water conservation increase by 0.6 percent.

Meaning as the age of the farmers increases, the probability of the farmers to maintain and use in continue manner the conservation structures decreases. This may be due to the fact that old aged people think that their life span is short and thus have limited interest in long term soil and water conservation investment. This result is similar with the finding of Habtamu (2006) who noted that older farmers are less likely to use soil and water conservation structures than the younger ones due to the fact that older farmers have short planning horizon compared to younger ones. Eleni(2008) also noted that the influence of the age on continue use of soil and water conservation is negative and insignificant .It is contrary with the finding of Chomba(2004) who noted that the younger age farmers are less likely to continue using soil and water conservation practices.

Credit access: The log likelihood estimates of model regression indicated that access to credit is positively and significantly influenced the decision to maintain soil and water conservation measures at ($P<0.1$).The model outcome indicated that household with access to credit increase by 1,the probability of decision to maintain SWC measures increases by 7 percent.

off-farm activity: The result of the logit model reveal that off-farm activity was positively and significantly affect the farmers decision to maintain SWC practices at($P<0.01$).

The model outcome indicated that the household involved in off-farm activities increase by 1, the probability of decision to maintain SWC practices increase by 21 percent. This approved that farmer household involved in income generating activities are more likely to decide the maintenance of soil and water conservation when compared to those household farmers not involved .

4.4.2 Tobit model regression of sustainability indicates of soil and water conservation measures

Tobit model analysis has been used to examine the determinants on decision to the amount of soil bund, stone bund and hill side terrace SWC measures maintained per previously constructed the last 5 years in Kuyu District .Among soil conservation technologies soil bund, stone bund and hill side terrace were chosen and used as three proxy measures of conservation effort. When the amount of maintained which measured in meter were divided by each of these three conservation technologies constructed the last 5 years it is taken as ratio and accordingly the analysis is done with the selected explanatory variables as below indicated in table 4.4.2 and so that the outcome of tobit model regression analysis are presented. The tobit model fit analysis was done for each of three selected dependent variables soil bund, stone bund and hill side terrace ratio and presented under table 4.4.2

Among sixteen hypothesized explanatory variables fourteen of them were found to significantly affect at least one of the three chosen ratio of improved SWC technologies (soil bund, stone bund and hill side terrace) positively or negatively

Twelve variables significantly affected soil bund, nine variables affected stone bund significantly while four variables significantly affected hill side terrace. The log likelihood ratio for all cases were differently significant at the $P<0.01$, $P<0.05$ and $P< 0.1$ .This implies that there exists useful information in estimated Tobit model.

The result indicated that the significance at (1%) variables affecting decision to maintain regularly which at least one of the three SWC practices were twelve variables in number that includes , Family size, , year of plot management, marital status, Sex, educational level ,soil type ,source of plot, credit access, slope, plot fertility, off-farm activity and degree of erosion.

Variables such as Age, Family size, distance from home, slope, plot fertility,, marital status, education level ,source of plot and soil type in another way affected one of the three conservation technologies significantly at 5% and 10% probability level. Among all variables only Land holding size and agricultural extension contact did not have coefficient significantly different from zero in any of the three equations.

Soil bund*:* From determinant factors the age, family size and plot fertility are negatively influenced farmers house hold decision to maintenance of soil bund type of soil and water conservation measures at 5 and 10 percent level of significance.(Table 4.4.2) The incidence rate of these variables

are 0.11 and 0.43 implying that the likelihood of soil bund maintenance for sustaining sustainability increased by 11 and 43 percent if age and family size of house hold farmers decreases by one unit. *Ceteries paribus*

The marital status, soil type, source of plot, off-farm activity, credit access, slope and degree of erosion influenced positively farmers house hold decision to maintain soil bund types SWC practices at 1 percent level of significance while distance from home to farm land affects positively at 5 percent of significant level.

As indicated in Table 4.4.2 the negative sign of age indicates that as house hold farmers' age decreases the maintenance of improved soil bund of soil and water conservation technology increases. Therefore the result is contradicts with the hypothesis that younger farmer households do not expend more effort on improved SWC measures particularly soil bund compared to older ones. This enabled to approve that even if older farmers have more experience younger are better and early adapter so that have more aware of the problem of erosion and importance of SWC measures .It is in line with the findings of Long (2003) and Wagayehu and Lars (2003) and in the other words contradicts with the Yazie (2013) and Fikru (2008) which the findings were older farmers are more likely to maintain conservation structures than younger counterparts.

The family size of households has an impact on the investment of SWC practices. From result of analysis (Table 4.4.2) As family size of household is decreases by one unit the decision to maintain soil bund structure increased by 43 percent. The findings are in line with the idea that larger families do not spend their money on conservation practices, rather they spend it for food and other basic necessities Wagayehu and Lars(2003),Yazie (2013)

Similarly Amsalu (2006) found that, in the Beressa watershed in the high lands of Ethiopia, larger families were less likely to conserve using stone bund, Bekele and Drake (2003) also found similar result in the eastern high lands of Ethiopia. They noted that in family with large number of mouth to feed, there was competition for labor between off-farm activities to earn cash for buying food.

More over as population increases, land holding per household gradually decreases which in turn has a negative impact on soil and water conservation.

Stone bund: The influence of family size, year of plot management, education level, and credit access on the maintenance performance of SWC is positive and statistically significant at 1 % level with

stone bund. In similar way distance from home to farm plot, marital status, source of plot and slope are affects farmers house hold decision to stone bund structure positively at 5 and 10 percent significant level.

There is significant correlation between the education level of household head and decision to maintenance of stone bund .education increased the maintenance level of improved stone bund by 31% per additional year of education (Table 4.4.2).This provide support for hypothesis that better education level are associated with greater information on soil conservation measures and in turn results in greater adoption of SWC practices. Krishana et.al(2008) found that education of household head was positively related to adoption and continue use of SWC practices. Therefore if the amount of educated people increases, the country sustainable development will be achieved.

The source of farm plot is one of the determinant economic factors considered in the study which affects decision to maintenance of stone bund structure. The farmers used shared in and rented in farm lands were less likely to decide to maintain improved stone bund type of SWC measures compared to the house hold farmers owned inherited farm land. The result is match with Bakhsh,Kanwar and Ahuja,(1998) farmers are not likely to invest in rented in and shared in land property if it is unlikely that their investment can be recouped,

Hill side terrace: The education level, soil type and plot fertility influences positively while distance from home to farm land affects negatively the decision of farmers household to maintain hill side terrace at 5 and 1 percent significant level. The incidence rate of distance to home from farm land is 0.10 implying that the likelihood of hill side terrace types of SWC measures decision to maintenance increased by 10 percent.(Table 4.4.2).

Interestingly the smaller the distance to farm land from home the greater the decision to maintenance of hill side terrace .For each minutes decreases in walking to farm land the hill side terrace decision to maintenance increased by 10 percent

Soil type is one of the determinants that clay soil type is with negative effect of decision to retain SWC practices at statistically significant level ($P< 0.01$). This reveals that farmers with clay soil farm land which regarded as fertile soil were less likely decides to maintain conservation structures than households with red soil type that assumed as less fertile. Therefore we conclude that farmers with less fertile soil were more attempts to improve soil fertility by maintaining hill side terrace structures

of SWC than farmers with high fertile soil type or clay soil. The probability may be decide to retain conservation structures on less fertile soil is to increase the crop productivity per cultivated land which are the crucial problem in the study area

Table 4.4.2. Estimation result of tobit regression model on determinants influence the maintenance of soil and water conservation measures (soil bund, stone bund and hillside terrace) maintained to previously constructed the last 5 years ratio

Explanatory variables	**Soil bund**			**Stone bund**			**Hill side terrace**		
	Coef.	**Std. Err.**	**P>|t|**	**Coef.**	**Std. Err.**	**P>|t|**	**Coef.**	**Std. Err.**	**P>|t|**
AGE	-.1112**	. 0474	0.020	.0370	.1198	0.757	.0059	.0500	0.905
FAMSIZ	-.4377 *	.2505	0.082	-1.7249 ***	.6431	0.008	-.0945	.2357	0.689
LHSIZE	.0123	.0259	0.634	.0851	.0719	0.237	.0015	.0416	0.971
DFHO	.-1073 **	.0419	0.011	.-1948*	.1000	0.052	.-1085**	.0509	0.034
YPMHH	.0505 .	0397	0.204	-.8161***	1062	0.000	.0241	.0400	0.547
HHSEX									
Female	-4.5939***	1.6108	0.005	-1.9432	3.6959	0.599	.0951	1.7296	0.956
MSHH									
married	9.9660*	5.7277	0.083	15.7548	13.2872	0.237	2.5391	4.3578	0.561
Divorced	7.2102	1.8724	0.000	8.6367 **	3.9612	0.030	1.2601	1.6388	0.443
HHEDU									
read and write	1.2065	.8701	0.167	.3172	2.1561	0.883	.4939	.9792	0.614
primary school	2.7857	1.1306	0.014	9.2917***	2.5682	0.000	2.2328**	1.0619	0.036
secondary school	3.5937	1.6947	0.035	12.7619	3.3006	0.000	1.4551	2.0159	0.471
BSC degree and above	-	4.2637	0.071	10.8998	5.4545	0.047	1.6781	2.0043	0.403
SOTYP									
black	-6.9383	1.6001	0.000	-.5957	2.4047	0.805	-3.5410	1.0827	0.001
loam	6.6243	1.3193	0.000	-2.7671	3.2985	0.402	4.4215	1.1207	0.000
sandy	.5993	1.0277	0.560	-12.0375	4.3111	0.006	.8488	1.6953	0.617
clay	-12.0556 ***	3.5436	0.001	-18.2606	**7.8806	0.021	-8.3608***	2.0776	0.000
SOPLOt									

Obtained from kebele	1.3707	.9256	0.140	18.2878	2.2685	0.000	.0793	1.0320	0.939
rent in/out	.-1238	1.8633	0.947	-3.1050	4.3230	0.473	-.0539	2.0907	0.979
shared in/out	-10.1722 ***	2.3313	0.000	-17.9885	**7.2181	0.013	-2.2928	1.5593	0.142
OFFACT									
Yes	7.0245***	1.1416	0.000	1.6147	2.5916	0.534	.9170	1.0903	0.401
AGEXT									
yes	1.3854	1.2516	0.269	3.8083	3.3323	0.254	2.2143	1.3799	0.110
CRDACSS									
Yes	7.3368***	1.0482	0.000	12.1727 ***	2.1983	0.000	.9708	1.0105	0.337
SLOPE									
Gentle slope (6-15%)	2.5700 ***	.8174	0.002	2.9204	2.0966	0.165	1.4506	1.0072	0.151
steep slope (> 15%)	.8637	1.2034	0.473	7.8664 **	3.1482	0.013	-1.9457	1.9111	0.309
PLOFE									
medium	1.2019	.3881	0.002	.5544	.8948	0.536	1.0368***	.3427	0.003
low	2.1363 *	1.1208	0.058	2.1100	3.0317	0.487	.3971	1.9287	0.837
DEGERO									
medium	.5730	.3963	0.149	.2602	.9961	0.794	.2785	.3695	0.452
low	-6.4260 ***	.8086	0.000	-2.3747	2.2821	0.299	-.8206	.6809	0.229
_cons	-3.7290	.3381	0.000	-7.3470	.7975	0.000	-6.1564	.2975	0.000
/sigma	4.8891	.3329		10.4905	.7859		2.3885	.3591	

Tobit regression

	Soil bund ratio	Stone bund ratio	Hill side terrace ratio
Log likelihood	-438.6280	-387.2135	-71.4084
No of observation	339	339	339
LR Chi2(27)	228.17	161.27	(25)=151.07
Prob >Chi2	0.0000	0.0000	0.0000
PseudoR2	0.2064	0.1723	0.5140

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary

Agricultural development in Ethiopia is hindered by land degradation; degradation in turn is threatening the overall sustainability of agricultural production. Soil erosion is a major cause of land degradation in Ethiopia. Using and retaining soil and water conservation technologies have paramount importance to reduce adverse impact of soil erosion particularly for small scale farmers practicing subsistence farming countries like Ethiopia. This study was conducted to identify the determinants that influence continued use of SWC measures in two kebeles of Kuyu District, central high lands of Ethiopia. Based on the result of this study among demographic, socio-economic, institutional and biophysical factors most variables significantly affect the probability of farmers' decision to retain SWC practices that determine continued use.

.To answer the research questions household survey conducted on 339 randomly selected households from two kebeles of the Kuyyu District. Different sampling procedure employed to select the sample households. The study employed descriptive statistics, inferential statistics (t-test, and chi-square test) and econometric method to analyze collected data. Descriptive and inferential statistics are used to describe explanatory variables used against farmers' decision to maintain soil and water conservation structures.

In this study, Logit regression is employed to estimate the effects of determinant factors on households' decision to maintain and while tobit model was used to analysis on decision and maintenance level of soil bund, stone bund and hill side terrace type of SWC measures with determinants

Sampled households asked whether they are decided to maintain SWC practices in terms of binary logistic analysis and the result revealed that ten explanatory variables affected the farmers' decision to maintain at significant level while the tobit model analysis showed fourteen variables found to have significant effect at1%.5% and 10% significance level at least one of the selected SWC measure soil bund, stone bund and hill side terrace.

. Through binary logit of econometric analysis the explanatory variables reveals that marital status, age, education level, family size, , agricultural extension contact, off-farm activity, access to credit , slope, year of plot of management and degree of erosion significantly affected at the 1, 5 and 10 percent probability levels

5.2 Conclusion

Based on the data collected from the study area and analysis made using statistical methods this research presented important information, justification and findings concerning conservation efforts made in the area. Hence forth from descriptive and econometric analysis result it is observed that the retaining and sustaining system of existing technologies of soil and water conservation in the study area is characterized as problem and was influenced by different determinant factors. Recently out of total sample households in the study area eighty nine respondents (26.3%) were not decided to maintain or either removed the SWC measures while the remaining two hundred fifty respondents (73.7%) were maintained.

The overall analysis of the households' attitude and level of decision indicated that that majority have positive view regarding SWC technologies so that enabled them to maintain regularly. On the other hand attitudes that undermine the severity of soil erosion problem and low perception on the merit and positive impact of physical and biological soil and water conservation measures were found to be challenges for most of the respondents that force them either to remove or not maintain in the study area.

Based on the findings the respondents that decided to maintain and not maintain are varied in many of demographic, socio-economic, institutional and biophysical variables. There is a significant difference in case of marital status, age, education level, family size, , agricultural extension contact, off-farm activity, access to credit , slope, year of plot of management and degree of erosion between two groups. Except family size and age that were significance and have negative influence the other quoted explanatory variables are significant and affected positively the continued use of soil and water conservation measures via used binary logistic regression.

In similar way the tobit regression analysis revealed that among sixteen explanatory variable fourteen of them were found to be significant on decision to maintain at least one from the selected three types of SWC measures namely soil bund, stone bund and hill side terrace Among all variables only Land

holding size and agricultural extension visit did not have coefficient significantly different from zero in any of the three equations.

Furthermore household survey analysis and key informants interview revealed that from the biophysical factors the high level of slope or steep land is identified as a predictor that influenced significantly whereas mass campaign SWC policies and strategies that fail to account for inter household and inter plot variation affected continued use and unlikely to be effective. This implies that when the farmers were not active participant of program design, they may tend to develop a sense of externality for the programs that undertaken even on their own land. In the other words live stock holding from economic factors is one of the predictor affect negatively the continued use of the soil and water conservation practices.

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5.3 Recommendation

- Since biophysical variables such as slope of farm land and degree of erosion are significant and positively correlated with land degradation and so that determine the continued use of the soil conservation technologies hence forth appropriate strategy options need to targeted by environmental agents and concerned body to increase the capacity of the households for proper level of maintenance.
- The households with the age of low level were more likely to decide the maintenance of the existing SWC technologies in compared to old aged farmers so that it is necessary to motivate the farmers when their ages are increasing high via preparing field days and trainings so as to enhance the level of their consciousness towards the merit of soil and water conservation practices.
- From key informant and FGD discussion analysis mass campaign implementation strategy of SWC measures was fail to change the attitude and perception level of farmers towards the positive impact of conservation measures so that necessary to consider inter households and inter plot variation differences during designing, promotion and implementation
- The soil type variable is influence the decision to maintain in the way that farmers prefer to maintain the farm land with low fertility status that exhausted and degraded .Therefore the recommendation is concluded to emphasize and shift the attention in conserving soil before the land lost all the fertile soil and nutrients.
- The off-farm activity and access to credit were influenced the sustainable use of soil conservation

technologies positively since households are able to provide construction instruments most probably assumed from the income they earned from income generating activities involved in and loan received from credit institution, hence forth it is necessary to pay attention on designing and promoting income generating activities and credit sources by Government and other concerned bodies..

- The agricultural extension contact is positively influences the continued use of SWC practices hence the development agent need to enhance the level of the contact and focus on natural resource conservation innovation rather involved in local political administration at grass root levels

- From result of descriptive analysis the live stock holding was one of the important economic variables that affect the existing SWC structures. Since farmers are used open grazing the destruction of physical and biological soil conservation measures were commonly observed. Hence forth farmers are advised to reduce their livestock numbers by promoting improved breed and as well recommended to use controlled and zero pasture land grazing management.
- Education is one of the strong explanatory variables that was significant and positively influence the continued use of SWC technologies. Therefore practical and theoretical trainings, adult education, field days and home visit extension methods is recommended to be given by Ministry of agriculture and concerned stalk holders in daily, weekly and quarter basis both for illiterate and literate household farmers so that enhanced their skill and knowledge.

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7. Appendix

7.1. Appendix I

Questionnaire for house hold survey

Addis Ababa University, Colleague Development study

Department of Environment and Sustainable Development

The objective of this questionnaire is to collect information from woreda farmers related to determinants of sustainability of soil and water conservation measures in Kuyu woreda. The study is conducted for academic purpose only. Hence, I request honest and fair response to fill these questionnaires

Master thesis survey

General information

Questionaries' No_____

Rural kebele_____

Village_____

Date of interview_____

One way travel distance from woreda town _____ in minutes

One way travel distance from market_____ in minutes

Part 2. Household characteristics

2.1 Respondent name_____

2.2 Sex: 1= male 2= female

2.3 Age in years_____

2.4 Marital status 1= married 2= Not married 3= Divorced 4= Widowed

2.5 Education levels of house hold head

1=illiterate 2=- read and write 3=primary school 4=secondary school 5= Diploma graduate 6= BSC degree and above

2.6 Family size: Male_____ Female_____ Total_____

2.7 Family size including house hold head

No	Age	Male	Female	Total
1	Below 15 years			

2	15-64 years			
3	Above 64 years			
4	Total			

2.8 social status 1= religion leader 2= kebele level official 3= Traditional leader 4= None of them 5=others specify

2.9 Farming experience in years_____

Part 3 . Land holding and farm characteristics

No	Type of land use	Area in hectare (ha)
1	Cultivated land	
2	Fallow land	
3	Grazing land	
4	Home stead area	
5	Forest(bush)	
6	Others use	

Part 4. Description of farm plots (write in the box to each plots as appropriate)

No	Description	Plot1	Plot2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7
1	Distance from home (walking minutes)							
2	Slope 1=flat (0-6%) 2= Gentle slope (6-15%) 3= steep slope (> 15%)							
3	Plots fertility 1= high 2=medium 3=low							
4	Source of plots (property right status) 1=Inherited							

	2=Obtained from kebele 3=rent in/out 4=shared in/out 5=others							
5	Number of years since the plot is under your management							
6	Describe the soil types 1= red 2=black 3= loam 4=sandy 5=clay 6=others specify							
7	Degree of erosion problem on the plot /vulnerability type/ 1=high 2= medium 3=low							
8	Irrigated 1=Yes 2=No							
9	Presence of at least one type of SWC structures 1=Yes 2= No							
10	Physical and biological SWC structures built in meter before 5 years 1= soil terrace 2=soil bund							

	3=stone bund 4=Fanyajuu 5=cut of drain 6=grass strips 7= other specify							
11	Who constructed the structures? 1=community mobilization 2=Family (hired)labor 3=financial incentives by government 4=labor exchange 5=others specify							
12	When year the following SWC structures were constructed? 1=hill side terrace 2=soil bund 3= stone bund 4=Fanyajuu 5=cut of drain in meter cubic meter 6=grass strips in meter 7= other specify							

13	The SWC structures removed in meter that constructed before 5 years 1= Hill side terrace 2=soil bund 3= stone bund 4= other specify							
14	Status (degree) of use of SWC structures 1=Removed totally 2=partially removed 3=Not removed 4=Modified(adapted)							
15	Was there any maintenances work done to the SWC structures? 1=Yes 2=No							
16	If yes How many of them are maintained in meter? 1=soil bund 2=stone bund 3=hill side terrace							
17	When year the maintenance work was carried out? 1=soil bund 2=stone bund							

	3=hill side terrace							
18	Who did maintenance work? 1=Community participation 2=Family labor 3=Hired labor 4=labor exchange 5=others specify							
19	How do you perceive the soil depth of your plot since you started SWC structure? 1=Increased 2=Decreased 3=No change 4=I do not know							
20	How do you compare the problem of soil erosion in your farm plots after conservation structures were built? 1=Aggravated 2=Reduced 3=No change 4=I do not know							

Part 5.Labor availability

5.1 Do you have labor shortage for your farm activities?

1= Yes 2= No

5.2 If the answer to question 5.1 is yes how do you solve labor shortage?

1= Hiring labor 2= by cooperating with other farmers (Dabo) 3= other specify

4=1 and 2

5.3 For which agricultural activities do you demand more labor?

1= Tilling or plowing 2= weeding 3= harvesting 4=SWC activities

5.4. If labor is hired what type of labor you hire?

1= Casual 2=permanent 3=both

5.5 Can you get easily labor whenever you need?

1= Yes 2=No

5.6 Which family members participate in SWC work?

1= Men 2= women 3= children 4=all of them participate

5.7 Do you or your family members work on off-farm activities?

1= Yes 2= No

5.8 If the answer to question 5.7 is yes in which of the following activities do you participate?

1= Handicraft 2=pottery 3= weaving 4= laborer 5=petty trade 6=selling of fire wood 7= others specify

5.9 If the answer from 1-7, which family members working non-farm activities?

1= Men 2=women 3= children 4= All

Part 6. wealth status of the respondents - Livestock

6.1 Do you participate in animal husbandry?

1= Yes 2=No

6.2 If yes for question 6.1 fill the following table

No	Types of livestock	Total number	Estimated price in (Birr)
1	ox		
2	cow		
3	calve		
4	Heifer		
5	Horses		
6	Mule		
7	Donkey		
8	Goats		
9	Sheep		

10	Chickens		

6.3 how is the present number of your animals as compared to the previous years?

1=Increasing 2= decreasing 3= remain the same

6.4 What is the main source of feed for your animals?

1= Grazing 2= Hay 3= straw/crop residue/ 4=all 5= others specify

6.5 How pasture lands are owned in your area?

1= Individually 2= communally 3=Both 4= others specify

6.6 Is there feed shortage for your animals?

1= Yes 2= No

6.7 If yes for question 6.6 what are the causes of shortage?

1= Expansion of crop land 2= degradation of land 3=expansion of settlements 4=others specify

Part 7.Institutional support

7.1 Do you get agricultural extension service?

1= Yes 2= No

7.2 If yes who provided the extension service?

1= Development Agents 2= NGO 3=All 4=others specify

7.3 How often you have been visited by DAs last years?

1=Once per month 2= twice per month 3= three times per month 4= once per three month 5= twice per three months

7.4 Have you participated in trainings of SWC for last five years?

1= Yes 2=No

7.5 were training useful?

1=yes 2= No

7.6 Do you participate in access of credit from saving and credit or multipurpose cooperatives?

1=Yes 2= No

7.7 Available formal credit in Birr_____

Part 8. Land tenure arrangement

8.1 Whom do you think land belongs to?

1= My own 2= the Government 3= others specify

8.2 Do you think that you have the right to inherit the land to your children?

1= Yes 2=No

8.3 Do you expect that you will use the land throughout your life time?

1= Yes 2= No

8.4 Do you agree if the government allows the farmers to sell their land?

1= Agree 2=Disagree 3=Difficult to decide

8.5 Have you rented in the land before?

1=yes 2= No

8.6 If yes who is responsible for keeping the rented land quality?

1= The owner 2= myself 3= both of us

8.7 Are your plots all registered?

1= Yes 2= No

8.8 If yes did you get certification for all plots?

1= Yes 2= No

Part 9. Perception on soil erosion problem and SWC measures

9.1 Do you think that soil erosion is a problem for your own farm plots

1= yes 2= No

9.2 How do you describe the degree of erosion in your farm land?

1= Severe risk of soil erosion 2=Moderate risk of soil erosion 3= Minimum risk of soil erosion 4= No risk of soil erosion

9.3 What do you think major causes of soil erosion ?

1= The slope of land being steep 2= Rain fall being too much or too heavy 3= Run off from up slope area 4= Soil being too erodible 5=Others specify

9.4 Which SWC structure do you have? (more than one answer is possible)

1= stone bund 2= soil bund 3= cut off drain 4= hill side terrace 5= farm land planting 6= others specify

9.5 If you are not constructed conservation structure what is the reason behind? (more than one answer is possible)

1= shortage of labor 2= shortage of land 3= my land do not require these structures 4 = do not believe in the use of SWC structures 5= others specify

9.6 If you are not maintaining conservation structures *constructed* in your farm land what are factors that discourage you from maintaining? (more than one answer is possible)

1= work is very tedious 2= cause loss of land to structure 3=high maintenance cost 4=lack of house hold labor to maintain 5= others specify

9.7 If you have made any form of destruction of conservation structures what is /are the reasons for the destruction? (more than one answer is possible)

1= search for fertile soil 2= joining plots 3=need to avail more land 4= destroying bad weeds 5= destroying hiding place of rodents pests 6= others specify

9.8 How do you recognize the productivity of soil conservation measures introduced to the area compared to the traditional one?

1= Less productive than traditional one

2= the same as the traditional conservation measures

3= More productive than traditional one

9.9 What is the slope of your farm land?

1= Gentle or flat 2=steep and very steep 3=Gentle and steep

Part 10. Soil and water conservation technologies and farmers attitudes

10.1 Do you know the existence of improved SWC measures?

1=Yes 2= No

10.2 If yes what is your source of information? 1= Neighboring farmers 2= Extension agent (DAs) 3=all 4=others specify

10.3 Rank the following types of SWC measures in the level of their importance or quality to reduce the problem of soil erosion?

No	Types of SWC measures	Likert scale /Rank/				
		1=least	2=less	3=medium	4=more	5=most
1	Soil bund					
2	Stone bund					
3	Cut of drain					
4	Water way					
5	Fanyajuu					
6	Planting of different trees					

10.4. Have you participated in community participation for conservation activities this year?

1= Yes 2= No

10.5 Do you believe that investment in SWC practices is profitable in the long run?

1= Yes 2= No

10.6 What are the problems related to each SWC structures?

No	Problems	Soil bund	Stone bund	Cut off drain	Water way	Plantation
1	Source of rodents					
2	Reduced farm land					
3	Difficult to run ox					
4	Labor intensive					
5	Difficult to implement (technically)					
6	costly					

7.2. Appendix II

Focused Group Discussion (FGD)

1. Discuss soil erosion problem in your farm land and what activities are done by the local community, government and non-government organization to reduce local impacts of soil erosion in your kebele?
2. Are these measures effective in controlling soil erosion problem for your farm? If yes how?
3. Do you participate in the design and planning of SWC measures before implementing of SWC structures?
4. What limitation problem do you face from the SWC measures implemented on your farm plots?
5. What general opinion do you have for the sustainability of SWC measures in you farm plots?

7.3. Appendix III

Interview checklists for key informants

1. How do you perceive about the following in your woreda as general and the study area in particular?

A) The major forms of soil erosion

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B) Causes of soil erosion

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C) extent and severity of soil erosion

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D) The perception level of farmers towards soil erosion

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2. What are local adaptation strategies the community has been practicing in mitigating impacts of

soil erosion?

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3. What do you think the major factors influencing farmers for use and maintain SWC structures in the study area?

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7.4. Appendix IV

Multicolinearity test for dummy /categorical independent variables

	sex	Marta.st	Education	Soil type	sourcplote	Off-farm	agext	Credit access	slope	plotfertil	Degre erosion
sex	1.0000										
Mart.st	.5630	1.0000									
Edu	-.0676	-.0334	1.0000								
soiltype	-.0810	.0563	.0404	1.0000							
sourceplot	-.0548	.0380	.0504	.1764	1.0000						
Off-farm	-.1950	-.0557	.0179	.1189	.0321	1.000					
agextn	.1453	.0614	.0510	.0214	.0104	.1209	1.000				
credit	-.1366	-.0037	.0763	.0151	.2885	.0669	.1145	1.000			
slope	-.0007	.0529	.0873	-.0756	.1749	.0954	.0034	.1085	1.000		
plotfertilit	-.0901	-.1104	-.0551	-.2050	.0623	-.0170	-.0169	.0106	.2399	1.000	
Degree oferosion	.0476	.0173	.0468	.0893	.1835	.2983	.1129	.0091	.2570	.3501	1.000

Multicollinearity test for continuous independent variables

	Collinearity statistics	
	Tolerance	VIF
Age	.685	1.459
Family size	.796	1.257
Land holding size	.987	1.013
Distance from home	.946	1.055
No of year of plot management	.809	1.237