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COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR ENVIRONMENTAL STUDY

DEPARTMENT OF WATER RESOURCE MANAGEMENT

DETERMINANTS OF SOIL AND WATER CONSERVATION MEASURES IN KOGA WATERSHED IN NORTHERN HIGHLAND OF ETHIOPIA, UPPER BLUE NILE BASIN, ETHIOPIA.

BY:

ENDESHAW ADDISU SHAREW

JUNE, 2020

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ADVISOR:

ERMIAS TEFERI (PhD)

A THESIS SUBMITTED TO CENTER FOR ENVIRONMENTAL AND DEVELOPMENT STUDIES AS A PARTIAL FULFILLMENT TO REQUIREMENT DEGREE OF MASTER OF SCIENCE (MSc) SPECIALIZATION IN WATER RESOURCE MANAGEMENT.

JUNE, 2020

ADDIS ABABA, ETHIOPIA

DECLARATION

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Place: Addis Ababa University, Addis Ababa, Ethiopia.

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ADVISORS APPROVAL SHEET

This to certify that Mr. **ENDESHAW ADDISU SHAREW** have conducted a thesis entitled "DETERMINANTS OF SOIL AND WATER CONSERVATION MEASURES IN KOGA WATERSHED IN NORTHERN HIGHLAND OF ETHIOPIA**,** UPPER BLUE NILE BASIN, ETHIOPIA".

This thesis submitted in partial fulfillment of the requirements for the degree of masters of science (MSc) specialization in water resource management; the graduate program at college of development studies, center for environmental and development studies; has been carried out under my supervision. Therefore, I decide that the student has fulfilled the requirements and hence hereby can submit the thesis to the center of environment and development studies.

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Name of advisor	**Signature**	**Data**

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We, the undersigned, members of the board examiners; the final thesis open defense presented by **Mr. ENDESHAW ADDISU SHAREW** have examined the candidate and evaluated his thesis entitled **"DETERMINANTS OF SOIL AND WATER CONSERVATION MEASURES IN KOGA WATERSHED IN NORTHERN HIGHLAND OF ETHIOPIA, UPPER BLUE NILE BASIN, ETHIOPIA"**.

Discussion of members of the board of examiners;

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Name of the chairperson	*signature*	*date*
Azage G/Yohannes (PhD)		7 July 2020
Name of external examiner	***signature***	***date***
Engdawork Asseh		7. 01. 20
Name of internal examiner	***signature***	***date***

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ABSTRACT

This study was conducted to assess the main determinants of implementation of soil and water conservation measures in Koga watershed, northern highlands of Ethiopia in upper Blue Nile Basin. Two case study kebeles were selected using stratified random sampling to represent the upper site of the watershed dega (highland) and middle site of the watershed which has woina dega agro ecological zones. A total of 132 households were selected for simple random sampling techniques for farmer's level assessment of the main determinants of implementation of soil and water conservation measures. The study found that the major soil and water conservation measures being employed where physical soil and water conservation which is stone bound, hillside terrace, micro water ponds, stone faced soil bund, check dam and fanya –juu terrace and also agronomic conservation measures which is contour farming, agroforestry, mixed cropping and crop rotation; and biological conservation measures like afforestation, area closure and grass strip are well implemented. This study also indicates that, even if the adopted soil and water conservation measures were essential to enhance soil fertility, lack of awareness on soil and water conservation, land shortage, lack of road infrastructure in soil and water conservation measure implemented area and wealth statues of the farmers were determining the household level to implement soil and water conservation practices in their farmlands. Farmers need to be encouraged to implement soil and water conservation measures through the use of the productive incentive work payments. Ethiopian federal and local government should also support and encourage different interventions like increasing following period, reducing intensive cultivation in hilly land, integrated use of soil and water conservation practices and extension of micro irrigation systems to replenish the degraded land characteristics, to improve crop production and decrease sediment load to Koga dam.

Key words: soil, water, conservation, adoption, determinants, measures, Koga watershed

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List of Acronyms and Abbreviation

ANRSFRE	Amhara National Regional State of Federal Republic of Ethiopia
DA	Development Agent
EHRS	The Ethiopia highland reclamation study
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
FTC	Farmers Training Center
GEF	Global Environmental Facility
GTP	Growth and Transformation Program
GO	Government Organization
Ha	Hectare
HHs	Households
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
m. a.s.l	Meter above sea level
MoA	Ministry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
NGO	Non-Governmental Organization
SWC	Soil and Water Conservation
SLM	sustainable land management
WFP	World Food Program

CHAPTER ONE

1. Introduction

1.2 Background of the study

In the last 40 decade Land degradation is a series problem across the sub-Saharan African countries this implies that soil erosion is one of the major problems experience.d globally. This is popular in East Africa, the harshness of land degradation is reported to vary from place to place, from one country to another. In Ethiopia for example, 25 percent of the total land is degraded. Comparatively, the proportions of land degradation in Kenya and Tanzania is 15 and 13 percent respectively (Kirui & Mirzabaev, 2016). These problems are highly influences for the reduction of agricultural production and productivity capabilities. Additional, it also negatively affects the natural water storage capacity of watershed areas, man-made reservoirs and dams, quality of surface water, the aesthetic value of the landscape and ecological balance (Woldeamlak, 2007).

Land degradation influence on crop production, which is crop production systems are expected to reduce food to keep peace with the global population that will amount to 9.1 billion people in 2050 and over 10 billion by the end of the century (UNFPA, 2011). The population of the world is growing by approximately one billion people per decade. Land degradation and consequent decline in soil fertility has become a serious threat to agricultural productivity in sub- Saharan African (Smaling and Stoorvogel, 1990). The declining fertility of soils because soil nutrient mining is regarded as a major cause of decreased crop yields and per capita food production in Africa; and decreasing soil fertility accompanied with increasing population pressure is one of the major cause of the gap between demand for and supply of food (Henao and Baanante , 2006).

Ethiopia is endowed with a favorable environment that supports various life forms including agricultural crops. Agriculture is the main economic activity for the majority of the population and its contribution to the national economy is also very significant. According to FAO (1997), it accounts for about 85% of the GDP, 85% of the exports and 80% of the total employment.

Agriculture is the major source of livelihood in Ethiopia and it is not only an economic activity but also a ways of life for which Agricultural land is a necessary resource upon which the benefit of the society is dependent on it. This types of dependence clearly leads to increased vulnerability of the economy to problems related to land degradation (Wegayehu, 2003). Even if land provides a means of livelihood, land degradation in the form of soil erosion, soil fertility depletion, deforestation through clearance for cultivation and overgrazing is among the basic problems facing farmers in the Ethiopian highlands. The Ethiopian highlands have been experiencing decreasing soil fertility and serve soil erosion due to intensive farming on steep and fragile land (Amsalu, 2006). Through the government of Ethiopia has made several interventions, the country still loses a great amount of fertile topsoil, and the threat of land degradation is expansion alarmingly (Akalu, Graaff and Stroosnijder, 2014). According to FAO (2011) repot, the soil fertility needs to be maintained, farming systems need to be transformed to increase the productive capacity and stability of smallholder crop production. This shows that give the better attention about alternative means of intensification, particularly the adoption of soil and water conservation practices in the watershed level.

In Ethiopian, SWC programs started in the formal way in the 1970s after the famine of the highly degraded part of Tigray and Wollo area. From that time up to the late 1990s, implementation was a top-down, incentive-based approach that prioritized engineering measures (Shiferaw & Holden, 1998).However, this program was not successful and sustainable due to the implementation approach. Currently different results suggest that watershed management had a positive impact on natural resource conservation, crop-livestock production and productivity, socioeconomic conditions and livelihoods when all the stakeholders are participate in conservation management process. But, its implementation process has different difficulties such us, lack of integration in bio-physical measure, absence of integrating practices, negative impact of incentives, lack of considering socio economic profile, low awareness of participation SWC practices, poor physical conservation design, improper land use, less maintenance on farm lands, week monitoring and evaluation of SWC are major constraints for the implementation of SWC in Ethiopia (Fikirie & Beyene, 2017). Now, mostly necessary measures must be taken to ensure voluntary participation and to remove the misunderstandings of all the concerned participants of SWC (Mahesh & Belay, 2018). Ethiopia has great climatic variety, from dry to wet, and also many different altitudes, from lowlands to highlands, the same conservation measures cannot be applied for everywhere and also the factors affecting the adoption of SWC measures vary from place to place. However, challenges of SWC measures to practice in the koga watershed had never been investigated. Therefore, this study tried to address determinants of implement SWC measures in the watershed, determinant factors that affect for adoption of SWC measures and evaluating the extant SWC practice status of farmers. Hence: knowing these problems has contributed to koga dam Ruther than social, economic and environmental uses. The koga dam was built in this area.

It has a high rainfall area and the soil type is affected by runoff, then the dam is highly affected by sediment. Therefore, there is an effective soil and water conservation measure and it is used to reduce soil loss by 50% (Ageur and steven, 2016).

Therefore, conducting this study will be very important to examine the determinants and extent level of implementations of soil and water conservation measures in koga watershed and reduction of the sedimentation from the dam by SWC measures implementation.

1.2 Statement of the problem

One of the immediate problems facing Ethiopia today is land degradation, particularly soil and vegetation degradation but Land degradation, which includes degradation of vegetation cover, soil degradation, water pollution and nutrient depletion, is a major ecological problem in Ethiopia (Temesgen Zewde, 2012). Soil erosion is a very severe problem in the highlands of Ethiopia especially in northern and central highlands of Ethiopia (Hurni, 1993).

According to the Soil Conservation Research Project (SCRP) 1986, estimate about one billion metric tons of soil are eroded every year from Ethiopia. Similarly, the Ethiopian Highlands Reclamation Study (EHRS) estimated that the rate of land degradation would cost ETB 15,261 million between 1983 and 2010 (World Bank, 2017). Of these costs, about 78% is due to losses in the cropping area and about 22 percent due to decreased livestock production. The estimated cost of soil degradation on the highlands did not take into account the downstream effects of soil erosion (FAO, 1986).

Loss of arable land due to soil erosion is a widespread phenomena in the highlands of the Amhara region, which accounts for about 66 percent of the total area of the region (Lakew, *et al*, 2000).

Koga watershed is one of the highly affected area by sever soil degradation, in koga watershed the annual soil loss of the koga watershed extends from 0 (at Koga reservoir) to 265 tons per hectare per year in the narrower steep slope part of the watershed with a mean annual soil loss of 47 tons per hectare per year (Habtamu and Amare, 2016). Very severe soil loss observed in the narrower steep slope upper part of the watershed at a rate that exceeds the tolerable soil loss limit. And a poor SWC practice seems to be responsible for land degradation. The koga watershed has a total sediment load carried by the koga river is estimated to be 90 ton per hectare over eight years and its mean annual sedimentation in flow is obtained as 175,000 tons. The annual sediment load by SWAT is thus 860 tons per km^2 or 8.6 tons per hectare per year (Demesew & Alemaw, 2016).

The Koga watershed is under a high rainfall area and the soil type is affected by runoff, then the dam is highly affected by sediment. Therefore, there is efficient and effective SWC work and it is used to reduce soil loss by 50% (Ageur and steven, 2016).

Therefore, in the Amhara regional state, west Gojjam zone, Mecha woreda koga watershed is severely affected by land degradation which includes soil erosion, nutrient reduction, degradation of vegetation cover and heavy sedimentation on down site, which is koga dam is be undertaken to identify the key determinants of SWC practices. By considering effective investment on soil and water conservation measures had been made in the middle and lower part of the watershed irrespective of the watershed.

1.3 Research questions

1. What are the current and common SWC measures practiced in the study area?
2. What are existing problems in the overall adoption processes of the SWC measures?
3. What are the solutions well implemented in SWC practices in the study area?

1.4 Objectives of the study

1.4.1 General objective

To assess the determinants of soil-water conservation practices in Koga watershed and recommend better intervention mechanisms that would contribute for the sustainability of the watershed.

1.4.2 Specific objectives

1. To describe the common SWC measures undertaken in the study area.
2. To identify the determinants of adoption of SWC measures in the study area in the last five years.
3. To recommend better intervention mechanisms that would assist in the future SWC practices.

1.5 Significant of the study

The farming system of smallholder farmers is not only diverse and complex but also risk-prone. Research institutions that aim to develop improved technologies (like SWC measures) for farmers who operate under complex farming situations, therefore, have a major challenge. Farmers need to understand the diversity, not only as one moves across ecological zones and regions but also across diverse farming systems to meet the diverse needs with different cultures, educational background and aspirations even within a given zone. Despite many research works and proposals in combating and reversing soil degradation, it continues to prove to be a substantially insidious problem. And the rural poor find themselves trapped in a vicious cycle of poverty and soil erosion fuelled by lack of relevant knowledge and appropriate technologies and opportunities to overcome such problems and generate adequate income to their livelihoods. The determination of challenges influencing decision on practicing soil and water conservation is essential in taking measures to alleviate the constraints affecting adoption of soil and water conservation structures. Identification of challenges that accelerate or slow down the adoption of SWC measures can enhance the formulation and the implementation of the measures dissemination programs.

The outcome of the study will generate information for different stakeholders, engineers, researchers, policy makers, governmental and non-governmental organizations, and farmers' local level organizations to implement effectively and develop effective sustainable SWC practices and strategies.

Moreover, this work plays its own share for researchers and extension specialists to utilize the results of this study in modifying research and extension activities.

1.6 Limitation of the study

This study has some limitations and faced some constraints: From these, a financial constraint was the main drawback during conducting this study.

The data collection time (March to April) was found to be inconvenient for most of the farming population in the study areas as it was peak agricultural activity season. Most farmers were unwilling to spare their scarce time for interviews. The time allocated for the survey was found to be insufficient to arrange and integrate some of the questions in the questionnaire and to make proper follow-up and control of the data collection process. Even though the household questionnaire interviewed to each household was designed to be brief, it was lengthy and in some areas some of the questions were not understood by interviewees and development agents and woreda land use and development officers are not volunteer to give interviews.

However, the researchers have attempted and took all the best to make study effective and valuable work.

1.7 Ethical Considerations

In the course of this responsibility, a suitable acknowledgment and citation have been made for any concepts or ideas taken from the literature. Moreover, formal letter of support was written to Mecha Woreda governmental office concerned body from center for Environmental studies. Explanation was given to farmer about the purpose of the research. Verbal consent from the respondents was requested before conducting the interview. They were informed that confidentiality of individual farmer household information was to be ensured by using unique identifiers. There were no known risks or worries associated with the study. Participation in this study was completely volunteer and that they were free to with draw from the study at any time without any opposition.

CHAPTER TWO

2. Literature Review

2.1 Soil Erosion in Ethiopia

Natural resource degradation is the main environmental problem in Ethiopia. The degradation mainly manifests itself in terms of lands where the soil has either been eroded away and/or whose nutrients have been taken out to exhaustion without any replenishment (Fikru, 2009). The majority of the farmers in rural areas of Ethiopia are subsistence-oriented, cultivating impoverished soils on sloppy and marginal lands that are generally highly susceptible to soil erosion and other degrading forces. Soil erosion is a phenomenon, which mainly occurs in the highlands of Ethiopia (areas >1500 meters above sea level) which constitute about 46% of the total area of the country, support more than 80% of the population, and account for over 95% of the regularly cultivated land and about 75% of the livestock population (Akalu, 2004). In Ethiopia, erosion averages 42 metric tons per hectare per year on currently cultivated lands and 70 metric tons per hectare per year on formerly cultivated degraded lands (Donald and Brown, 2000). About 45% of the total annual soil loss in the country occurs from cultivated fields, which accounts for only 15.3% of the total area (Borin, *et.al*, 2005). The latest land degradation estimates indicate that out of the 52 million hectares of land making up the highlands of Ethiopia, 14 million hectares are severely degraded, 13 million hectares are moderately degraded and two million hectares have practically lost the minimum soil cover needed to produce crops (Boserup, 1995). According to Gebremedhin (1998), Ethiopia loses annually 1.5 billion metric tons of topsoil from the highlands by erosion.

A study by Bekele and Drake (2003) shows that the problem of soil erosion is compounded by the fact that some farmers dismantled the conservation structures built in the past through food for work incentives. Consequently, the cause of land degradation makes soil erosion in Ethiopia and declining fertility is seriously challenging agricultural productivity and economic growth. Soil erosion by water is by far the greatest land degradation problem. Aleneh (1990) and Wegayehu (2003) stated that the most ubiquitous cause contributing to agricultural land degradation was soil erosion. IFAD (1992) also made clear that measures of land degradation usually focus on the severity of soil erosion.

Under extreme gully erosion, farm activities are extremely affected by this soil erosion magnitude. It needs the considerable efforts made during the past three decades. Hence, many studies attribute water erosion, particularly on cropland, as a major cause for such a high level of soil erosion in Ethiopia (Bekele and Holden, 1998). The role of overgrazing is significant in fueling soil degradation since it is integrated into a smallholder farming system (Belay, 1992).

2.2 Factor of Soil Erosion in Ethiopia

Soil erosion is a natural process and worldwide phenomenon. Now, soil erosion as the demand for food climbs, the world is beginning to mine its soils, converting a renewable resource into a non-renewable one (Brown and Wolf, 1984). The problem of soil erosion is not only the threat for the developing countries, but also it is the threat for an agriculturally sophisticated world. For instance, Brown and Wolf (1984) describe that even in an agriculturally sophisticated country like the United States; the loss of soil through erosion exceeds tolerable levels on some 44 percent of the croplands. The continual growth demand for agricultural products contributes to soil erosion in many ways. Thus, throughout the Third World, farmers are pushed onto steeply sloping, erosive land that is rapidly losing its topsoil. In other areas farming has extended into semi-arid regions where land is vulnerable to wind erosion when plowed (Brown and Wolf, 1984).

In Ethiopia the severity of soil erosion can be attributed to intense rainfall and rugged and dissected nature of the topography with nearly 70 percent of highlands having slopes exceeding 30 percent. Rapid population growth, cultivation on steep slopes, clearing of vegetation, and overgrazing are the main factors that are accelerating soil erosion in Ethiopia (Lulseged and Paul, 2008). In the highlands of Ethiopia, deforestation has reduced tree cover to 2.7 % of the surface area, About 50–60% of the rainfall is estimated to be lost as runoff, carrying 2–3 billion tons of the top soil away annually (Hurni H. , 1988). The annual rate of soil loss in the country is higher than the annual rate of soil formation. Hence, the underlying cause for the excessive rate of soil loss is the unsustainable exploitation of the land resource which is manifested by extensive de-vegetation for fuel wood and other uses and expansion of cultivation and grazing into steep land areas (Kibrom and Lars, 2000; Woldeamlak, 2003; Aklilu and de Graaff, 2006). Besides, despite the considerable efforts made to develop and promote different types of soil and water conservation technologies, acceptance, adoption and sustained use by the land users have not been widespread for various reasons (Bekele and Holden, 1998; Aklilu and de Graaff, 2006; Alemayehu, 2007; Woldeamlak, 2007). Soil erosion is as well caused by lack of efforts in conservation and largely remains a problem to be tackled at ensuring food security, poverty reduction and environmental sustainability. Soil erosion has led to the degradation of agricultural land and consequent reduction in agricultural production thus exposing the population to food insecurity (Paulos et al., 2004).

2.3 Soil loss In North Highland of Ethiopia

According to the Ethiopian highland reclamation study (area above 1500m), sheet and rill erosion and the interrelated physical degradation produces are the dominant degradation process on land degradation and annual soil erosion rate was estimated to 1.5 billion tons (Hurnl, 1986) (table 1).

From all land use and cover types, the severity is worst on cropland, where the annual soil loss rate is in the range of 42 tons /ha/year. The Ethiopia highland reclamation study (EHRS) estimated that the annual soil erosion rate on the highland is 1.9 billion tons, of which10% of it is carried away irretrievably by the highland rivers (Weldemariam, 2017) and (Hurnl, 1986).

Table 1: Estimated soil loss from different land use and land cover types (Hurnl, 1986).

Land Use Land Cover Types	Estimated Area (%)	Estimated Soil Loss	
		Tons/ha/yr	Tons/yr
Crop land	13.1	42	672,0000,000
Perennial crops	1.7	8	17,000,000
Grazing land	51	5	312,000,000
Currently unproductive land	3.8	70	325,000,000
Currently uncultivated land	18	5	114,000,000
Forest	3.6	1	4,000,000
Woodland and shrub land	8.1	5	49,000,000
Total	100	12	1,493,000

2.4 Soil loss Estimation in Koga Watershed

Soil loss by runoff is as ever and continuous ecological problem in the Koga watershed. Deforestation, improper cultivation and uncontrolled grazing have resulted in accelerated soil erosion. Information on soil loss is essential to support agricultural productivity and natural resource management.

The result revealed that the annual soil loss of the watershed extends from none in the lower and middle part of the watershed to 256 tons per hectare per year in the steeper slope part of the watershed with a mean annual soil loss of 47 tons per hectare per year. Most of these soil erosion affected areas are spatially situated in the upper steepest slope part of the watershed. These are areas where Nito soil and alisoil with higher soil erodibility character (0.25) values are dominant. Hence, slope gradient and length followed by soil erodibility factors were found to be the main factors of soil erosion. Thus sustainable soil and water conservation practices should be adopted in the steepest upper part of the watershed by respecting and recognizing watershed logic, people and watershed potentials (Habtamu and Amare, 2016).

2.5 Adoption of the Soil and water Conservation Measures in Ethiopia

In the Previous 1974 revolution, soil degradation did not have the policy attention it deserved (Hurni, 1993; Wegayehu. B and D. Lars, 2003). The famines of 1973 and 1985 provided a momentum for conservation work through large increases in food aid (imported grain and oil). Following these severe famines, the then government launched an ambitious program of soil and water conservation supported by donor and non-governmental organizations (IFPRI, 1992). The use of food aid as a payment for labor replaced voluntary labor for conservation campaigns (Campbell, 1991) and (Campbell, 1991). Supporting this inspiration, Pender (2004) stated that soil conservation measures have relied largely on food-for-work programs as an incentive and have been oriented toward labor-intensive activities such as terracing, bund construction and tree planting. With this, Ethiopia became the largest food–for-work program beneficiary in Africa and the second largest country in the world following India (Campbell, 1991). A total of 50 million workdays were devoted to conservation work between 1982 and 1985 through food-for-work. Between 1976 and 1988, some 800,000 km of soil and stone bunds were constructed on 350,000 ha of cultivated land for terrace formation, and 600,000 ha of steep slopes were closed for regeneration (wood, 2001). These conservation structures were introduced with the objectives of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production/ availability (Daniel, 2008).

Soil erosion poses a serious threat to national and household food security (Bekele and Holden, 1998). And therefore its management is essential for improving food security in seriously affected areas of Ethiopia (Tesfaye, 2004). Initially, most of the soil conservation works included construction of the stone and earth embankments, which the farmers believed took extra land from their small land holdings and sheltered rodents. Available evidence shows that the adoption of soil and water conservation measures has been very limited (Akalu, 2004). A study by Shiferaw and Holden (1998) shows that the problem of soil erosion is compounded by the fact that some farmers dismantled the conservation structures built in the past through FFW incentives. In fact, until the early 1990s farmers were not allowed to remove the conservation structures once built on their land. This shows that the conservation efforts have also neglected the pronounced regional disparities within the country and have frequently been implemented in a top-down manner, excluding the participation of the local community (Kessler, 2006). It is further clarified that some techniques such as terracing and other land management practices can increase productivity and thus profitable in some area like in low rainfall area, but the same techniques are much less profitable in other areas like in high rainfall areas because they can actually reduce farmers yields by reducing the effective area of the plot, causing water-logging, or harbor pests. However, the introduction of an economic reform program in the 1990s and subsequent liberalization of the economy brought more freedom and hence conservation structures could be removed if the land users so wished. Conservation practices have mainly been undertaken in a form of campaign and quite often farmers have not been involved in the planning process (Kessler, 2006). This shows that soil conservation projects implemented in the country failed to consider local peoples economic, demographic, institutional and technical factors from their very inception. Obviously, the adoption of soil conservation technologies considerably is influenced by different factors. Among other influences, the characteristics of farmers such as age, education, household size, farm size and experience are some major influence for the decision of application of soil conservation. The age of a farmer is an important characteristic of a farmer that affects adoption of soil conservation technology. Relationship between age and application of soil conservation technologies has been seen from different points of views. Age of the farmers tends to influence negatively the conservation decision in that it decreases participation in environmental protection (Belay, 1998).

Correspondingly, a study conducted by Adesina and Zinnah (1993) revealed unenthusiastic relationship between age of a farmer and adoption whereas Negatu and Paikh, (1999) in the case of Bangladesh acknowledged a positive relationship between age and adoption of conservation technology. Yet other studies carried out by Tigist (2009) found no relationship between age and adoption of a technology. According to Rogers (1983), exposure to education may enhance the awareness of a new technology and hence increase the capacity of the farmers to apply a given technology. Other case studies in Uganda by Boserup (1995) indicated that education had a significant effect on farmer's choice to adopt maize production technologies. Also to Ervin (1982) education was found as significantly related to conservation efforts. For Tilahun, (1996) education enhances farmer's willingness to adopt new techniques by improving the management capacity of farmers. The size of the household has been recognized to positively influence the application of soil conservation technology by Woldeamlak (2003), which identified lack of interest in soil and water conservation measures to be explained by shortage of labor. Thus, household size influences the decision of farmers to undertake the conservation measures given household labor is the whole supplier of the required labor for undertaking the farming and soil conservation operation. In contrary to this, household size was identified to negatively impact the intake of the technology in the study carried by Wogayehu and Drake (2003) in which indicated that in the large families with greater number of mouth to feed, immediate food need is given priority and labor is diverted to off- farm activities that generate food rather than practicing the soil conservation technologies. In another study by Bekele and Holden (1998) in Andit Tid, Ethiopia, household size has been identified to have a negative and significant effect on adoption of soil conservation practices. Farming experience can also determine farmers‟ awareness of and interest to a given technology and their ability to implement it.

Besides to the farmers socioeconomic characteristics, practicing soil conservation measures could also be influenced by land characteristics such as slope, soil color and moisture holding capacity, the distance of cultivation field from the homestead. Slope of the cultivation fields either motivates or demotivates farmers towards decision to practice soil conservation measures. Hence, farmers located in steeper slopes tend to control soil erosion through use of appropriate measures whereas the counterparts delay in application of soil conservation methods owing to being situated on flat slopes. The study of Tekelu and Gezahegn (2003) stated that farmers cultivating steep slope fields install more effective conservation measures than farmers that cultivate level fields. They detailed that soil degradation is better perceived among farmers of the highly degraded areas than their counterparts in less degraded areas. On the contrary, farmers in less erosion prone areas (level fields) do not employ conservation measures on their farmlands. Other study by Wogayehu and Drake (2003) and Bekele (1998) found positive association between existence of recommended types of conservation structures and concluded that slope affects farmer's decision to adopt conservation structures positively. Also Dvorak (1998) observed frequent conservation practices installed on steeply sloping cultivation fields which reflect the desire of farmers to control soil loss from highly erodible soil. According to Wegayehu and Drake (2003), approximately farmers recognize the effect of soil erosion when the erosion reaches at critical level, which is very difficult to oppose the degradation of soil at the farmer level. Farmers will not be interested to participate in conservation mechanisms and accept related risks if they do not observe significant risk on productivity of soil erosion. Farmers that cultivate black soil invest in soil conservation more whereas farmers that cultivate other soil colors adopt conservation practices less frequently.

2.6 The implantation of soil and water conservation practice in the highlands of Ethiopia

Soil and water conservation measures introduced by the Ethiopia government in 2010 recently, under the growth and transformation programs (GTP), have positively impacted on watersheds in northern Ethiopia. The Ethiopian government launched a land restoration that aimed to double agricultural productivity through improving the management of natural resources and agricultural lands (MOFED, 2010) and (GTP, 2016). In SWC practices program, the regional bureaus of agriculture, district agriculture offices and other local administrative bodies mobilized farmers to help with the construction of SWC measures. Since 2010, more than 15 million people have contributed free labor equivalent to US $750 million each year. Physical and biological SWC measures have been introduced in more than 3000 watershed movements by local communities (Growth and Transformation Plan of Ethiopia, 2016). Such benefits of SWC works on north highland of Ethiopia are (Wolde Mekuria, 2016):

SWC measures should be designed to accommodate peak rainfall events and be able to adequately collect runoff and trap sediments during such times. A sound understanding of groundwater dynamics in a watershed is necessary to be able to design and implement SWC measures that can successfully reduce runoff and sediment yield. Variability in soil types and landscapes (e.g upper slopes vs. lower slopes) affects the efficiency of different SWC measures and should be considered when designing and placing such measures. Gully treatment and stabilization should complement integrated SWC measures in a watershed to be reducing annual sediment loads and soil losses as well as to prevent siltation of reservoirs. Constructed SWC measures should be maintained every two to three years to sustain their function in runoff and sediment reduction (Wolde Mekuria, 2016).

2.7 Farmers' Perception towards Soil Conservation Measures

Understanding farmers perception of soil erosion and its impact is important in promoting soil and water conservation technologies (Chizana, *et.al*, 2006). Soil erosion is an insidious and slow process therefore farmers need to perceive its severity and the associated yield loss before they can consider implementing soil and water conservation practices. That is the only 25% of the rehabilitation targets have been accomplished by farmers and most of the physical soil conservation measures and community forest plantations are destroyed (Borin, 2005). Different farmers may have different attitudes towards soil conservation. Those attitudes may also affect the selection of soil conservation practices. Sometimes, farmers who have good attitudes also may not practice soil conservation due to the socio-economic failures (Wubneh, 2004). Borni, *et.al*, (2005) has paid particular attention to attitudes towards conservation. They combined economic and psychology theories and found that conservation decisions were influenced not only by context variables, such as tenure, income and farm terrain, but also by attitudes. In the report carried out by IFPRI (1992) to identify the reasons for the success and failure of soil conservation programs, Hurni, (1993) described that world-wide, 500 million people live in subsistence agricultural systems on steep lands. Their survival directly depends on soil conservation to be implemented on an immense scale within the next few years. However, there are many constraints for soil conservation. Bekele, (2003) considered soil erosion as an outward symptom of unskillful agriculture, thus the first step in the halting of soil erosion must be the allocation of a higher proportion of national funds to the improvement of agriculture and forestry. In relation to this, other experts have also argued that awareness of the existence of the problem is the first step in the adoption process and is positively correlated with the adoption of soil erosion controlling mechanisms (Ervin, 1982). Perceiving the soil erosion problem and positive effect of soil conservation measures also provides stimulus to and shapes opinions about to adopt conservation practices that stop the problem (Daniel, 2008). However, (Belay, 1992) and Woldeamlak (2003) in their study found that in spite of high levels of farmers‟‟ perception of soil erosion problems, the level of adoption of conservation structures was very limited. Thus, perception of erosion problem is not a sufficient condition for adoption of soil conservation practices though it is a necessary one (Woldeamlak B, 2003). Practice of traditionally known soil conservation methods tends to be influenced by some factors. For instance, farmers well know the importance of crop residues in enhancing soil fertility. However, crop residues and animal dung is used for fuel energy and other home use. IFPRI (1992) described that removal of plant materials impoverishes the soil, as it is no longer possible to recycle the nutrients present in the residue.

2.8 Bund structure dimensions in koga watershed

Expanded soil drying and severe moisture stress during the dry season, and soil saturation and erosion during the short rainy season are critical problems in the Ethiopia highlands. Large scale implementation of bund structures has been used as soil and water conservation measures to fight these problems and establish a sustainable land management (SLM) system. However, many SWC measures are implemented with design flaws or without proper design and maintenance, and do not match conservation requirements. The quality of implementation and effects of these bund structures on soil physical property is not yet documented. The dimensions and stability of bund structures, and consequently, the impact of bunds varied widely. The widths and heights of bunds, and slope gradients were significantly correlated with infiltration rate and soil water content. Soil water content was 24% higher compared to that on untreated farms. Bunds with larger dimensions of top width >85cm% and height 75cm% showed 17 and 18 % higher soil water content compared to fields with bunds having lower dimensions. In addition, the porosity and soil depth were significantly affected by the dimensions of bund structures and increase with increasing width and heights of bunds. A 14% increase in porosity; a 41%increase in infiltration rate; and 18% decrease in bulk density were found in soil of treated farms compared to those of untreated farm plots. Different in practice size distribution and soil erodibility among widths of the bund were low. It can be concluded that bund structure design varied substantially through the watershed. This impacted soil water storage and soil physical properties. Bund structure design should be adapted to local biophysical settings at watershed level to enhance on- and off site impacts (Lakew, 2018).

2.9 Soil and water conservation measures in koga watershed

Bund structures including stone-faced soil bunds, soil bunds, stone bunds and Fanya juu bunds are wide spread conservation strategies in Koga watershed. Stone bunds are implemented mainly on steep slopes where stones are abundant and soil bunds are common on middle and low slope positions where there is limited availability of stones. Stone-faced soil bunds are the most widely applied conservation structures throughout the study area. These bund structures have been implemented at variable dimensions of height and width over large areas through community mass mobilizations. Traditional ditches have different sizes, spacing and gradients and are constructed every season by ox plough to dispose excess runoff in farm plots between successive bunds. Recently, integration of biological conservation strategies for stabilization of bund structures and gully treatment with plantation of trees like Sesbania sesban and grass species has become more popular (Jemberu et al., 2018).

2.10 Policies related to SWC in Ethiopia

There was no government policy on soil conservation or natural resources management in Ethiopia prior to 1974. The 1974-1975 famine was the turning point in Ethiopian history in terms of establishing a linkage between degradation of natural resources and famine. There was a more direct linkage in the public eye between highly degraded land and those afflicted by drought and famine in the Ethiopian highlands. In 1978, a highly publicized article, which circulated in Addis Ababa, pointed out that about one billion tonnes of top soils were being lost every year in the famine-stricken Ethiopian highlands (brown & wolf, 1978). This and a similar effort by others, raised awareness of the threat of soil erosion to the viability of smallholder agriculture. In 1981, the ministry of agriculture and the University of Bern (with the support of the Swiss government) initiated the soil conservation research project, which generated one of the first systematic data sets on the magnitude and the severity of erosion. In 1983, the Ethiopian highland reclamation study (EHRs) was carried out by national and international experts, which reviewed the main reasons for drought and proposed a conservation based strategy to address it (constable et al, 1985).

The natural resources base (land, water and forest) is fundamental to the survival and livelihood of the majority of people in rural Ethiopia. These resources are under intense pressure from population growth and in appropriate farming and management practices. Small scale farmers, who depend on these resources, face severe constraints related to intensive cultivation, overgrazing and deforestation, soil erosion and soil fertility decline, water scarcity, livestock feed, and fuel wood crisis. These factors often interact with one another and bring a downward spiral of declining crop and livestock productivity, food insecurity, high population growth rate and environmental degradation.

Closely connected to the need for a flexible extension programme is the urgent need to broaden the concept of soil and water conservation. As pointed out earlier, there is an implicit recognition by the MoA to this effect as reflected in its Five-Year Plan. Soil and water conservation should be seen as an integral part of soil fertility management, good agronomic practices, rainwater harvesting, increasing fodder, vegetative cover and fuel wood products in the village and community level. In this respect, the development of manuals at the Federal level clearly underlying this new approach in natural resources management, particularly in drought-prone areas, is urgently needed. This can be further elaborated and adjusted at Regional level. The 1986 soil and water conservation guidelines need to be updated urgently. It is understood the copy of these guidelines no longer exist in many areas.

2.11 Conceptual of the hypothesized determinants that influence SWC measures

The Theoretical framework of this study is based on the determinants of implemented soil and water conservation measures. The measures of adoption in the study is the actual presence of conservation structures on farmers' plots of land and farmers were asked whether conservation structure measures are done in their field and still exist or not in each plot of land. In this study farmers who have a plot of land on which SWC measures have been put up. Thus, the dependent variable is a function of demographic, socio-economic and institutional factors.

Analytical framework

This research would follow the analytical framework described in (Figure 1) which explains the relationship among variables that challenge the adoption of SWC which in turn affects the koga dam and extents of SWC measure practices in the watershed. They include demographic and socio-economic factors, perception, farm characteristics and institutional factors affecting adoption of SWC. The outcome of the study would be whether adoption of SWC measures is contributing to the lifetime of Koga dam or not. The linkage and interaction of determinants of adoption of SWC measures between the Dams are explained as follows.

Demographic and Socio-economic factors

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

Sex: the effect of sex may be either negative or positive SWC practice. The male headed the HH has a higher chance to be involved in SWC practice than female headed since constructing and maintaining SWC practice demands much labor and energy (Asfaw & Neka,2017). However, Mountain & Park, (2018) stated the negative influence of sex on SWC practice. On the other hand, sex of the household did not significant effect on SWC technologies (Mango et al., 2017; Mekuriawet.al, 2018).

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

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

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

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

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

Household head perception Factors

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

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

Farm characteristic factors:

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

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

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

Institutional factors

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

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

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

Adoption of SWC: confirmed in different studies the positive impact on irrigation dams as improving agricultural productivity contributing for irrigation water use.

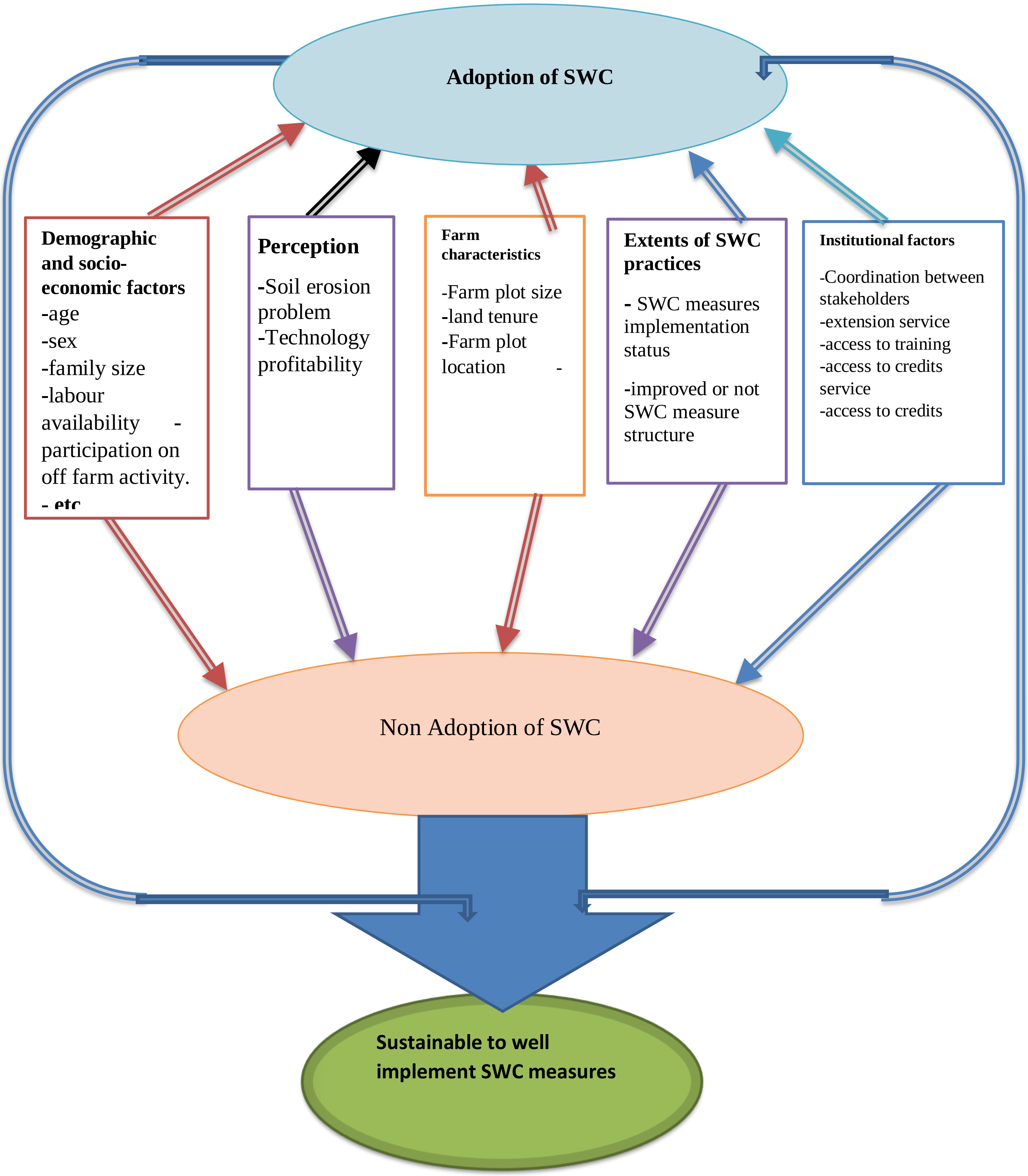


Figure 1: Conceptual Framework of the Study.

CHAPTER THREE

3 Research Methodology

3.1 Description of the study area

The study was carried out in the Koga watershed (Enashenfalen,Enamirt, Rim, Kurt-Bahir, Andinet, Kudmi ,Abromenor, and Midre-Genet kebeles) within 18 kebeles (sub-division of district) of the Mecha Woreda (district) as shown on Figure 2 shows some parts of the watershed. It is located between 11°10' and 11°25' North latitude and 37°2' and 37°17' East longitude in Blue Nile basin, within the Highland of Ethiopia which is located about 540 km North of the capital city, Addis Ababa (Figure 2). According to the Central statistical agency (CSA) of Ethiopia projection from 2014 to 2017, the woreda had a total population of 334,789 where 168,724 are males and 166,065 are females. The mean annual rainfall (RF) recorded at Merawi station is 1480 mm, of which 90% falls in the months May through October. The monthly mean temperature is 25.8°C. The elevation ranges between 1885-3131 m.a.s.l (meters above sea level), and the slope ranges from nearly flat to very steep. The mean annual runoff recorded at Koga station near Merawi for the years 1985-2003 is 176 MCM (Million cubic meters). The dry season limits the water availability in the study area.

The Koga watershed lies in the Blue Nile Basin and consists of land drained by the Koga River above its confluence with the Gilgel Abay (Little Nile). The Koga River flows south to northwest with a total length of 49 km to Gilgel (Little) Abay and Lake Tana; its tributaries effectively drain the total catchment area, which is 27,850 ha and lies to the North of the Wezem Mountains.

Soil erosion in the Koga watershed is severe and is the result of the mountainous and hilly topography, a low degree of vegetation cover and gully erosion. Soil erosion has made cultivation infeasible in several parts of the watershed. This together with increasing population pressure has forced farmers to constantly cultivate new and more marginal areas.

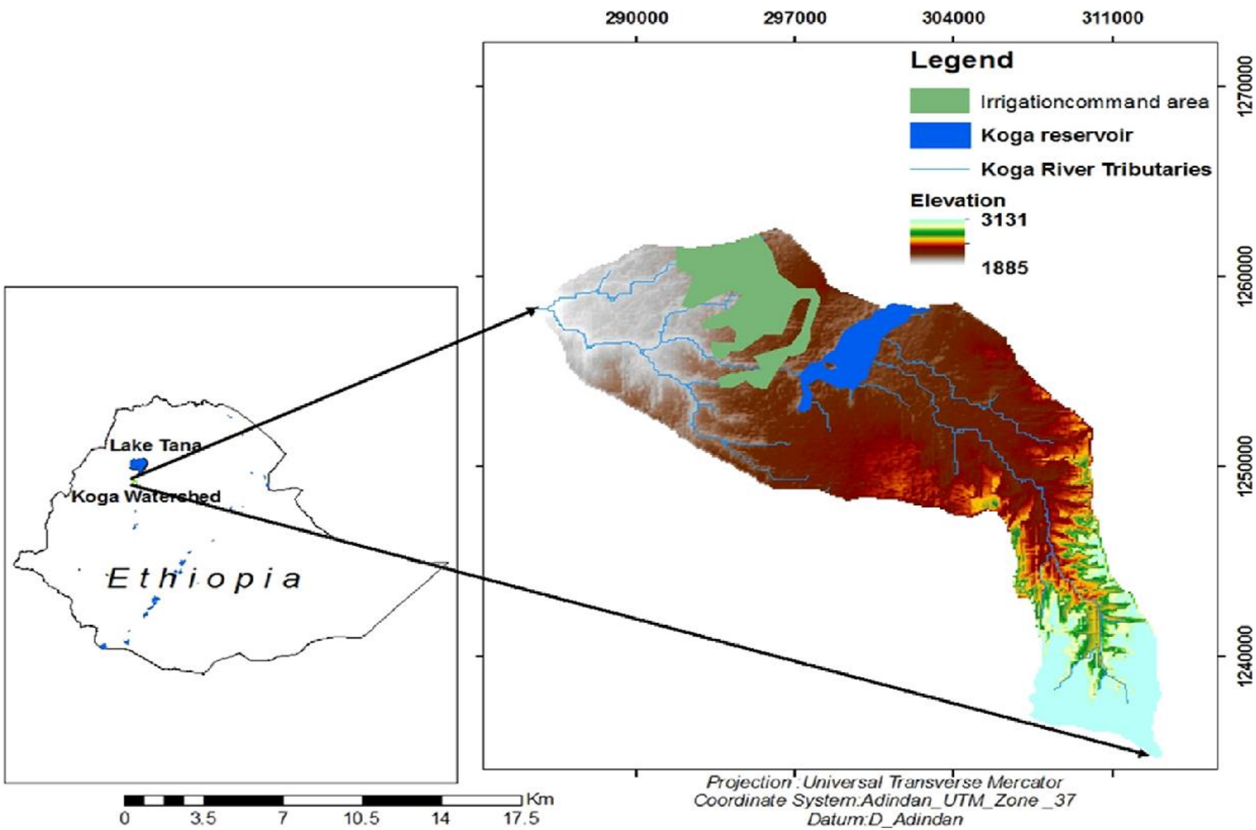


Figure 2: location of Koga watershed, Adapted from Habtamu and Amare, 2016.

The current problem in the Koga watershed is that most SWC efforts have focused on highly degraded areas with limited production potential and only the poorest farmers. Marginal steep lands have been terraced with a few structural SWC measures. Despite their promotion, the adoption of SWC practices by farmers has been limited. For example most farmers have not implemented stone bund terraces because they harbor rodents that consume the crop. As a result, land degradation remains a major threat to agricultural production.

3.2 Farming System in the study area

The identification of the natural resource constraints and potentials, on which the rural community livelihood depends, will be an essential element for successful implementation of any agricultural intervention.

Agriculture is the main economic activity and livelihood source of the people of the study area. It is characterized by mixed farming that includes both crop production including plantation and livestock rearing. Crop production is one of the most important components of agricultural activities on which most rural farmers practice and depend on for their living. The main crops grown widely in the area are maize, wheat, barley, bean, pea, Teff and Dagusa. Maize, Teff and Dagusa (small millet) are the most important annual field crops in its coverage and preference by farmers. The annual crops are mainly used for domestic use and source of income. The major constraints of crop production are shortage of rainfall period, cultivated land shortage, erratic rainfall, frost, hail, crop insect pests and disease and low level of modern agricultural inputs. Livestock production is also considered as the vital agricultural activity of the area. Livestock are considered as the important livelihood assets as they are used as a source of food, income, draught power and transporting of goods.

The major livestock types reared in the *woreda* are oxen, cows, heifer, bull, calf, sheep, goats, poultry, beehives, horse, mule, and donkey. The major challenges in relation to livestock production in the area include lack of grazing land, lack of feed, lack of improved breeds, livestock diseases and poor management practices.

During field work at all kebeles namely Enashenfalen and Abromenor have natural resources identified by the community been water/ irrigation and drinking/, arable land, grazing land and forest and forest is one an income generated mechanisms of the study area, especially, Eucalyptus tree is the mostly cover the farming areas of the farmers.

3.3 Adapted Soil and Water Conservation Measures in Study Area

The SWC Measures are the part and fragment of farming system evident in the study area. Almost of them farmers perceived erosion problems while many of them also believed that SWC measures are profitable (Teshome, 2013). Therefore, the different SWC measures practices are to prevent erosion problems were introduced by government and non-government organizations. Therefore, the most implemented SWC measures are Soil bunds, fanya juu bund and stone bunds are the major SWC measures that are widely implemented by farmers in koga watershed, rather than traditional terracing, water way etc. These SWC measures and other SWC measures were included in the evaluation.

Soil bunds

In common land epically in wina dega agro ecological zones this type of conservation measure easily practiced. Soil bunds are embankments made from topsoil along the contour to control erosion. They require less labor for construction compared to stone and fanya juu bunds as excavated material from the ditch is placed downhill rather than uphill, as is the case in the construction of Fanya juu bunds mostly it is common in Enashenfalen kebele. However, soil bunds require more labor for maintenance than Fanya juu and stone bunds. The uphill drains of the soil bund are impacted by accumulated material and therefore require more labor to regularly excavate the ditches, as farmers need to ensure effective evacuation of excess water. Grass is grown on the riser to stabilize the bunds. Soil bunds can be easily eroded during heavy rainfall in steeply sloping areas common in Enashenfalen kebele but soil bund is not easily practiced in Abromenor kebele because of the dega agro ecology is not satisfied to practices easily.

Fanya juu bunds

Fanya juu bunds are made by digging a trench and moving the soil uphill to form an embankment and are thus more labor-intensive during construction. A terrace can be created in a relatively short period of time. They provide an opportunity to grow fodder or grass on the riser, but they can also experience water-logging.it is practiced in both agro ecological zones they can exercise by soil and stone terraces in the two kebeles but the magnitude of implementation is different in each kebeles.

The fanya juu terraces is that it changes gradually into a bench terrace, does not need too much maintenance, and decreases the speed of runoff more than a soil bund. This is consistent with findings of earlier studies in southern Ethiopia. Tegene (1992) reported that the farmers considered the introduced soil and fanya juu bunds as inappropriate technologies because they occupy cultivable area, and they harbor rats and other rodents.

Stone bunds

This physical conservation measure is mostly practiced on the dega agro ecological zones, Abromenor is commonly exercise this SWC measure. Stone bunds are usually constructed where stones are readily available on or near the field. Stone bunds are stable and durable measures. They can reduce runoff and soil erosion in steeply sloping areas, and excess water can pass more easily through stone terraces. However, construction does require a large amount of labor. Furthermore, they are not convenient for ox-plowing and can harbor rodents.

3.4 Study Design

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

3.5 Research Methods

3.5.1 Sampling techniques

For this particular study the research used stratified random sampling techniques. The first step was proportionate stratified sampling selection of two kebeles namely Abromenor from dega ecological zone and Enashenfalen kebele from woyna dega ecological zone under koga watershed the upper site of the koga dam.

The second stage was the simple random sampling of households from the list of kebeles. To facilitate this final stage, lists of names of households in each selected kebele were obtained from the kebele chairperson, in the field extension officers and technical support organization operating in the study area.

The sample size household is determined by using the following formula with some degree of precision for general household head (Cochran, 1977).

That is:

$n^{\cdot}=\frac{z^2pq}{d^2}$.............................eqn. (1) **and**

n= $\frac{n^{\cdot}}{1+\frac{n^{\cdot}-1}{N}}$ ....eqn. (2)

Where, $n^{\cdot}$ = desired sample size when the population is greater than 10,000

n= number of samples size when population is less than 10,000

Z=95% confidence limit (z-value at 0.05 is 1.96)

P= 0.05 (proportion of the population to be included in the sample i.e. 5%)

Q=1 - 0.05 which is 0.95

N= total number of population (2136)

d=margin of error or degree of accuracy (0.07)

Since the population (HHs) of in the watershed will be involved in the study are less than 10,000 in number, therefore, both equations (1&2) were used to determine sample size required in this study as follow:

$n' = \frac{z^2pq}{d^2}$ = 1.96^2**(0.05) (0.95)**/ (0.07^2) **=125.27=125 and then**

n= $\frac{n'}{1+\frac{n'-1}{N}}$**=125/ (1+ (125-1/2136)) =105**

Therefore, sample size required (n) in the study was 105 HHs were used for precision. Donald, (1967) recommends taking a random sample of 10-20% of 125 which is 7.4 was added as contingency. Therefore, sample size used (n') in this study was 125+7 =132 HHs, which are 60 HHs from Abromenor kebele and 72 from Enashenfalen kebele. Which is **Proportionate stratified Sampling.** $ni = \frac{Ni * n}{N}$

ni = Sample size for i th stratum/ kebele

Ni = Population in i th strata which is 912 & 1224

N= Total Population which is 2136

n =n'=the sample size required which is 132

Table 2: Distribution of sample by agro-ecology and study kebele.

Agro-ecology zone	Population size (N)	Selected Kebeles	Allocation sample size(n')
Dega(highland)	912	Abromenor	60
Woina dega (near to the dam)	1224	Enashenfalen	72
Total	2136	2 kebele	132

3.5.2 Sampling procedure

The representative sample was selected from the total population under the study, from the total household farmers and kebele administration of Mecha woreda. Regarding procedure of sampling, use stratified random sampling design was employed. The kebeles was selected using proportionate stratified sampling way selected from two agroecology zones, which is Abromenor and Enashenfalen. The kebeles were selected stratified randomly depending on the two agroecology zones, proportionally allocating from each zone. Finally, HHH was selected systematic through simple random sampling.

3.5.3 Data Type, sources and tools

The study applied a combination of both primary and secondary data sources was used. Primary sources were obtained from household survey, group discussion, and personal observation and while books, articles, journals, legal documents, and related websites are sources of the secondary data source.

3.5.3.1 Primary Data

Direct observation

This study was carried out through watching, listening and recording of data. It helps to generate ideas helpful to modify questionnaires for survey, group discussion and key informant interview and also to acquire information about the physical setting of the area, conditions of land degradation, and status of the present soil and water conservation practices.

Household questionnaire

Household questionnaires were open and close-ended questions that were pre-tested and also developed in English and translated into Amharic which is the official working language of the Woreda. Interviews were conducted with household heads about socio-economic characteristics, perceptions on soil erosion and conservation measures, implemented SWC measures on their farm land, farm characteristics, institutional factor, and extent status of SWC practices and determinants on well implementing SWC measures.

Focus group discussion

Total of two focus group discussions were administered from two kebeles. The group members included a total member of 6 who are 2 elders, 2 religious leaders and 2 community teachers from both men and women. The aim of the discussion was on extent and major determinants to adopt SWC practices which used to enhance soil fertility and crop productivity.

Key informant interview

For the depth understanding of determinants and extents of SWC measures in the study area, Six key –informant were purposely selected from kebele administrators one each kebele totally 2 and one development agent (DAs) in each kebeles totally 2 key informants in each kebeles, one from koga project officers and one woreda agricultural office natural resource development expert. All these key informants had better understanding of determinants and extents of soil and water conservation measures in the study area.

3.5.3.2 Secondary data

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

3.5.4 Data Collection Procedures and Data Quality

All participants (n = 132) were provided with oral informed agreement. Primary and secondary data was collected. The data was collected by trained data collectors. One day of training on how to approach and fill out the questionnaire before they visited each household and interviewed the respondents in person and theoretical training about the subject area was given for two data collectors. And also to assure the quality of data the questionnaire was pre-tested, coding and data cleaning (checked frequencies and cross-tab for each item) were used.

3.5.5 Data Analysis Techniques

To analyze determinants affecting adoption of soil and water conservation measures is difficult because of differences in agro-ecological and socio-economic settings within which farmers operate (Bekele, 2003). To address this difficulty, it was assumed that every farmer has the objective to maximize utility, but each farmer has their own awareness of utility and makes SWC practice adoption decisions based on the unique attributes of their own situation and location. In other words, the adoption of soil and water conservation practices is assumed to depend upon the set of attribute values that apply to a plot of land, some of which are specific to the particular region, to the village, to the farm or to the plot within the farm. Farmers in the Koga watershed cultivate or manage several plots located at different distances from home. Each plot has different soil and environmental conditions. As a result, farm households may make different soil and water conservation decisions for different plots depending on specific circumstances and the importance of the plot to the household. This requires that data be interpreted at an individual plot level rather than aggregated across all plots of a household. Therefor; The Data was coded and entered into SPSS version 22 and exported to STATA version 14.2 for analysis. Descriptive statistical summary measures (i.e. means, standard deviation, frequencies, percentages and cross tabulation) were used to understand the collected data and also chi-square test for determining the association between HH determinants of implemented SWC measures and adoption on SWC measures.

Econometric model binary logistic regression was used to predict the relationship between SWC adoption and independent variables tested at 5% significance level. Binary logistic regression models were used to identify the major explanatory variables for determinants of implemented SWC measures, which adoption of SWC was as one variable.

For this analysis post-estimation tests were done after logistic regression. In order to test the existence of multicollinearity , both the continuous and discrete explanatory variables were checked using variance inflation factor (VIF).This statistical analysis indicates that there is no strong association among the variables (Annex 2 and 3). And also, heteroscedasticity and goodness -of- fit test was calculated to auto correlation and appropriateness of data with the model. The information gathered from focus group discussion, key-informant interview, and personal field observations (direct observation) were analyzed qualitatively.

3.5.5.1 Deals About Assessing Determinants Of SWC Adoption

In order to assess contribution of SWC to watershed management/for effective irrigation water use in the reservoir, it is felt necessary first to assess the adoption level of SWC in the study area. Adoption of SWC measures by a farmer was assessed using criteria indicated in Table 3.

Table 3: SWC measures adoption criteria.

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

Additionally, determinants of adoption of SWC practices were analyzed by binary logistic regression models using socio- economic, HHH perception, farm characteristic and institutional factors as explanatory variables for adoption of SWC measures and determinants of implementing SWC measures. Relationship between farmers existing implantation status and adoption of SWC measures was analyzed by chi-square test and also used adoption of SWC measures as an explanatory variable for extents of SWC measure practices.

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

P_i=F (α+βX_i) = 1/1+e-(α+βX_i)

Where: Subscript i denotes the i^{th}observation in the sample; P_i is the probability that an individual will make a certain choice given X_i; e is the base of natural logarithms and approximately equal to 2.718; X_i is a vector of exogenous; variables α and β are parameters of the model, $\beta 1, \beta 2 \dots \dots, \beta k$ are the coefficients associated with each explanatory variables $X1, X2, \dots, Xn$. The above function can be:

$$ln\,[P/(1-P)] \;=\; \beta 0 \;+\; \beta 1 X1 \;+ \beta 2\,X2 + \ldots + \beta k\,Xk$$

Where: $q\ /\ (1-P)$ is the odds (likelihoods); $\beta 0$ is the intercept; $\beta 1, \beta 2\ \dots\ and\ \beta k$ are coefficients of the associated independent variables of $X1, X2 \dots and\ Xk$. The effect of the independent variables (e.g., β1) is interpreted as the odds (likelihoods) of the outcome increases or decreases by a factor of $e^{\beta 1}$. The quantity $e^{\beta 1}$is called the odds ratio. The odds ratio is a measure of relationship between the independent and the dependent variables. While the estimated coefficients from logistic regression are not easily interpretable, odds ratios might provide a better summary. Marginal effects are an alternative metric that can be used to describe the impact of independent variables on dependent variables. Marginal effects can be described as the change in independent variables as a function of the change in independent variables holding all other variables in the model constant.

3.5.6 Description of variables

The dependent variable is adoption of SWC which is expressed as a dummy variable; which is 1 for adopter and 0 for non-adopter. The independent variables and their brief description are shown in Table 4.

Table 4: Description of independent variables that affect the adoption of SWC measures.

Variable	**Code**	**Type**	**Description with Measurement unit**	**Expected sign**
Age	HHAGE	Continues	Age of household heads (in years)	+ or -
Sex	HHSEX	Dummy	1 for male and 0 otherwise	+ or -
Family size	FAMSZ	Continues	Size of households (in numbers)	+
Education	HHEDU	Categorical	0 for unable to read,1for only read and write ,2 for formal education (primary and secondary school)	+
Perception of soil erosion as problem	PERSO	Dummy	1 if erosion is perceived,0 otherwise	+
Perception on SWC technologies profitability	PERTCE	Dummy	1if perceived profitable,0 otherwise	+
Participation of off-farm activity	PARTOFF	Dummy	1 if participate in off farm work,0 otherwise	-
Livestock ownership	TLU	Continues	Total livestock availability TLU unit	-
Farm size	FARSZ	Continues	Total farm area (cultivated land, grazing land, wood land, and bare land)**;** (in ha)	+ or -
Land tenure	LADTE	Dummy	1 if has feeling land ownership, 0 otherwise	+
Farm location	FARLOC	Continues	Average distance to home to farm area(in walking minutes)	-
Labor availability	LABAV	Continues	Number of full time HH member engaged on farm activity	+
Extension service	EXTSER	Dummy	1 if farmer contact with extension officers/DA's ,0 otherwise	+
Training on SWC practices	TRAN	Dummy	1if the farmer has been trained, 0 otherwise	+
Market distance	MAKTD	Continues	The distance of home to nearest market in (Walk by hrs.)	-
Access to credit	CRDT	Dummy	1 if received credit, 0 otherwise	+

CHAPTER FOUR

4 Result and Discussion

This chapter describes the descriptive and econometric model (determinants) results of the study. The descriptive statistic result includes demographic and socio-economic characteristics, implemented SWC measures and implementation approach, farmer's perception to soil erosion and control measures, SWC adoption status and extents of implement SWC practices. The econometric analysis section results show determinants of adoption of SWC measures.

4.1 Descriptive statistics

4.1.1 Demographic and Socio-economic Characteristics of Study Participants

A total of 132 respondents were included for the analysis of determinants of SWC practices to implement effective watershed management above the koga dam from two agroecology zones in koga watershed.

Among the study respondents of two kebele 64.4% are male headed and the remaining 35.6% are female headed. 53.3% of HHH were unable to read and write and only 32% of farming household was attending formal education that was completed primary school and secondary school and above, but 30% of the respondents were diploma and 70% first degree holders in the Key formative interview employment reported by respondents in the office. Out of the total respondents, only 24.3% of the HHH were participating in off-farming activities (table 5). Petty trade like oxen merchants (madeleb) and daily labor were the major source of off-farm activity.

Table 5: Distribution of sampled households by sex, education and off-farm activity

Category	Characteristics	n' (Number)	Present (%)
Sex of HHH	Female	27	35.6
	Male	105	64.4
Educational status of HHH	Unable to read and write	74	56.06
	Only read and write	26	19.6
	Formal education	32	24.4
Off-farm activity	Yes	32	24.3
	no	100	65.7
Woreda/kebele development agent officers	Female	3	33.3
	Male	6	66.7

Source: From own survey, 2019.

4.1.2 Age status of the household

Age Status of Households Three age groups for head of household are identified: 55% are between 20-40 years, 37% are between 40-64 years, and 8% are over 64 years. Most of the HH heads (92%) are in the age from 20-64 years group (Table 6). Farmers in this age group are assumed to have a good understanding of problems of soil erosion due to access to information, and as a result, usually more interested in soil and water conservation practices. The proportion of elderly farmers is 8%, an age group in which labor shortage can be a difficulty to practicing soil and water conservation measures on their plot land. However, these farmers usually implemented and accepted soil and water conservation practices because of having access to money for rented oxen as well as hired labor.

Table 6: Age distribution of HHH.

Description	Age range (years)						Total participants
	20-40		40-65		>65		
Number of HHH in age group	Number	%	Number	%	number	%	
	76	58	50	38	6	4	132

Source: From own survey, 2019.

4.1.3 Institutional and farm characteristics of the respondent

Amhara credit and saving institution is the only institution who serves credit for the communities in the study area. And also, about 25% of the HHH were used credit .The majority of the HHH take credit for the purpose of purchasing fertilizer but not any one were in use credit for the purpose of SWC technologies (measures) implementation. Out of the respondents, 32 % of the HHH were taking training on SWC measures and implementation techniques only twice in the last 3 years. At the Woreda level, the land administration and environmental protection office were distributing land certification for farming households. As a result, all farmers had land certificates and the majority of the farmers received maps of farming areas. About 86% of the household heads were feeling land ownership because of land certification with land maps. Farmers may have their plot located in different places. Some are very close to their homes while some may be located far from home. This result shown that farm locations were in the range of 15 minute to 90 minute with a mean of 26.4 minute. When compared agro-ecological zone farm location from their homestead.

Woynadega agro-ecology was relatively smaller in distance than the other agro-ecology. In the study area, there are two main towns and 4 small villages week day markets where Rim and Merawi are the towns. The farming households travelled with a minimum of ½ hours to 5 hours for purchasing agricultural inputs and selling their product in the main markets because agricultural inputs do not easily get in the nearest smaller markets.

Table 7: Farm and institutional characteristics of the study participants

Categories	Characteristics		Number(n')	Parentage (%)
SWC training	Yes		42	32
	No		90	68
Credit	Yes		33	25
	No		99	75
Extension services	Yes		116	87
	No		16	13
Land tenure	Yes		113	86
	No		19	14
	Min	Max	Mean	Stand.dev
Farm location in hour	14 or 15 minutes	1 & 1 2 or 90 minutes	26.4 minutes	28.2 minutes
Distance from market in hour	12	5	2.72	1.1

Source from my own survey.

4.1.4 SWC practices being employed by farmer

4.1.4.1 Physical conservation measures

Soil and water conservation measures common to all land use types are measures applicable to cultivated land, grassland and forest land. Their specifications are almost for all land use types, with only slightly different applications. On watershed physically implemented SWC measures have their own characteristics.

4.1.4.2 Stone faced soil bund

Table 8 below presents that level of stone faced soil bund in the study area (25%). Stone faced soil bund acts on slope 0-30 % (depending on rainfall, soil type and land use) both by interrupting slope length and by reducing its gradient. With proper maintenance, this may eventually lead to terrace formation by moving and compacting soil downhill (FAO, 1986).

Table 8: physical SWC measures employed across kebele.

Physical SWC measures	Abromenor		Enashenfalen		Total	
	n'	%	n'	%	n'	%
Stone faced soil bund	9	15%	24	33.3%	33	25%
Hillside terrace	21	35%	15	20%	36	27.7%
Stone bund	12	20%	-	0%	12	9%
Check dam	3	5%	24	33.3%	27	20.%
Micro water ponds	6	10%	6	8.3%	12	9%
Fanya-juu	9	15%	3	4.1%	12	9%

Source from my own survey.

Figure 3. Stone –faced soil bound practices in Abromenor kebele, photo from filed observation.

4.1.4.3 Hillside terraces

Table 8 shows that, the extent of adoption of hillside terraces were 27.7%.When we see the extent of hillside terraces across the kebeles, Abromenor kebele (35%) was dominated, Enashenfalen (20%). This also shows that there were more hilly and mountain farmlands in Abromenor kebele. Hillside terrace used to reduce surface erosion by rainfall, retain runoff for moisture conservation, promote establishment trees and shrubs and safely control the flow of water by diverting runoff from upland sloping areas or collection zones to a stable outlet sloping upland or collection zones (Nyssen J., 2007).

4.1.4.4 Stone bund

Stone bund was also practicable soil and water conservation measures in the watershed (9%).when we see the level of adoption stone bund across a few kebeles, mostly practiced in the dega ecological zone in the watershed. Which is Enashebfalen keble (0%) was dominated by Abromenor kebele (20%) on table 8. According to key formant respondents, if larger stones are plentiful on the land, these may be used to make the bunds. Under water limiting conditions, the stone bunds are efficient measures to improve soil water content through runoff control (MoARD, 2005). When rainfall is unpredictable, the stone bunds contribute to conserving more moisture in the soil for longer, which helps to alleviate water stress during day spells.

4.1.4.5 Check dam

Compared to stone bund and hillside terrace, the check dam was also mostly being implemented in the middle site of the watershed (20%). When we see the level of adoption of the check dam across the kebeles, Enashenfalen kebele (33.3%) was dominated by Abromenor kebele (5%). A check dam placed in the ditch, swale or channel interrupts the flow of water and flattens the gradient of the channel, thereby reducing the velocity of runoff (MoARD, 2005).

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. Check dams can be made of any material available locally, such as stones, live or dead branches, wooden poles, gabion today, soil and water conservation measures are not only socially accepted and integrated (MoA, 2016) .

Figure 4: Soil bund /soil check dam in Enashenfalen kebele, photo from field observation

4.1.4.6 Fanya- juu terrace

Compared to other physical SWC measures above, fanya-juu terrace was not much implemented in the watershed (9%). When we see the level of fanya-juu terrace across the kebeles, Abromenor kebele (15%) was dominated by Enashenfalen kebele (4.1%) Table 8. fanya –juu terraces are constructed by throwing soil up slope from a ditch to form a bund along a contour. Several of these terraces are made up of the slope following the contour lines.

Figure 5: Fanya - Juu soil bounds with functioning drainage ditches in Enashenfalen kebele, photo from field observation

4.1.5 Agronomic conservation measures

4.1.5.1 Crop rotation

Crop rotation entails growing various crops on the same piece of land (WDEQ, 2013), is well known agronomic measures in the watershed (56.8%). Crop rotation was mostly implemented in Enashenfalen kenele (58.3%) than Abromenor keble (55%) on the table analysis shows that. But in all parts of the watershed crop rotation agronomic conservation mechanism was implemented as the field observation shows. Crop rotation increases organic matter in the soil, reduces pests and diseases, improves soil structure, and reduces soil degradation (Kwesiga, 2003).

Table 9: Major agronomic conservation measures in koga watershed

Agronomic measures	Abromenor		Enashenfalen		Total	
	Number (n')	Percentage (%)	Number (n')	Percentage (%)	Number (n')	Percentage (%)
Crop rotation	33	55	42	58.3	75	56.8
Mixed cropping	12	20	6	8.3	18	13.6
Contour plowing	9	15	9	12.5	18	13.6
Agroforestry	6	10	15	20.5	21	15.9

Source from my own survey.

4.1.5.2 Mixed cropping

Mixed cropping is the practice of growing two or more crops in the same piece of landing a single growing season (WDEQ, 2013). Compared to contour farming, mixed cropping is an equally known agronomic measure in the watershed (13.6%). Mixed cropping was much implemented in Abromenor kebele (20%) than Enashenfalen kebele (8.3%) (Table 9). The implementation of mixed cropping is different from place to place, what it calls an agro ecological zone.

4.1.5.3 Contour farming

Contour farming is also similar to mixed cropping being implemented in koga watershed (13.6%). In which, it is dominated by Abromenor kebele (15%) followed by Enashenfalen kebele (12.5%) table 9. The purpose of contour farming is to prevent surface runoff down slope and encourages infiltration of water into the soil. Contour plowing can increase crop yields from 10 to 50%, partially as a result from greater soil retention (USDA, 1997).

4.1.6 Biological conservation measures

4.1.6.1 Afforestation

In the Koga watershed, public mobilization in the afforestation program has dramatically increased in the last 10 years. Since the watershed is endowed with mountainous topography, afforestation is currently becoming the best biological measure in the upper sit of the watershed (59.1%). When we see the level of implementation, Abromenor kebele (60%) leads Enashenfalen kebele (58.3%) table 9. Afforestation and reforestation programs has made and is making a very substantial contribute in the Highlands by the reclamation and protection of steep and/or severely degraded slope thus reducing run-off, improving water flow and storage regimes, and increasing availability of fuel wood, thereby decreasing the proportion of dung and crop residues used for fuel (FAO, 1986).

Table 10: Major biological conservation measures in koga watershed

Biological measures	Abromenor		Enashenfalen		Total	
	Number (n,)	Percentage (%)	Number (n,)	Percentage (%)	Number (n,)	Percentage (%)
Afforestation	36	60	42	58.3	75	59.1
Area closure	18	30	21	29.1	39	29.5
Grass strip	6	10	9	12.5	15	11.3

4.1.6.2 Area closure

Recently area closure is becoming public in the Koga watershed (29.5%). The extent of implementation of area closure in Abromenor kebele (30%) is better than Enashenfalen kebele (29.1%) table 10. area closure directly or indirectly contributes to the increase of crop yields, food production and improvement of farm income (Nyssen J., 2007).

4.1.6.3 Grass strip

In the Koga watershed grass strip is not well implemented (11.3%). But the degree of implementation of grass strips in Enashenfalen kebele (12.5%) is better than Abromenor kebele (10%).Grass strips used for the slope of the area from 0-8% which are alternative to terracing in which Grass is planted in dense strips, up to a meter wide, along the contour. These lines create barriers that minimize soil erosion and runoff, increases soil moisture, and silt builds up in front of the strip (FAO, 1986).

4.1.6.4 Public campaign participation and its constraints

The active involvement of different stakeholders in SWC implementation period is important to get sustainable SWC out comes. For the last many years governmental and recently sustainable land management projects facilitating SWC measures to recover land degradation and reduce level of soil erosion. This study showed all farmers not offered any incentives for participation in public struggle SWC activities.

Out of the total respondent, 91.6% of the household head or any member of the family participated in the yearly public SWC campaign from which 65.09 % were participating by their interest. Whereas, 9.09% were participating without their interest (Table 11).According to the information gathered from the DAs, concerned Check dam Traditional kab Maintenance on Stone bund persons of the government bodies and local kebeles leaders had facilitated without their interest to participate in public campaigns. FDG indicated, Farmers have different preferences with regard to SWC approaches, some farmers expected cash incentives from the government for participating in public campaigns and some of them invest their labor for their farm land rather than public campaigns.

During FDG one farmer's opposing public campaign implementation approach "*when he took SWC, why not investing my labor to conserving his land, why not government enforced, punished the owner of the land rather routinely pushing me to participating on SWC and why the government service rode infrastructure related to the SWC measure"*. And the other FGD participant took" *why the offices are doing together well implemented SWC on koga watershed specially woreda development and conservation and koga project officers"* This implies there was gap between the community and government towards SWC practices implementation approach, this way of gap had created a determinate for the sustainability and quality of SWC practices.

In these findings, the majority of the respondent perceived that major determinants for implementation of SWC measures were that it required too much labor, the farmers had low perception of soil erosion as a problem and lack of monitoring land management system and also 2.2% were other constraints for public campaigns: such as implementation approach. Out of the total study participants, 46.9% of the farming households conducted maintenance on their SWC measures. During my observation time, after harvesting period some of the constructed measures were damaged by livestock due to no road infrastructure in SWC measures implementation area as a result routine maintenance was required.

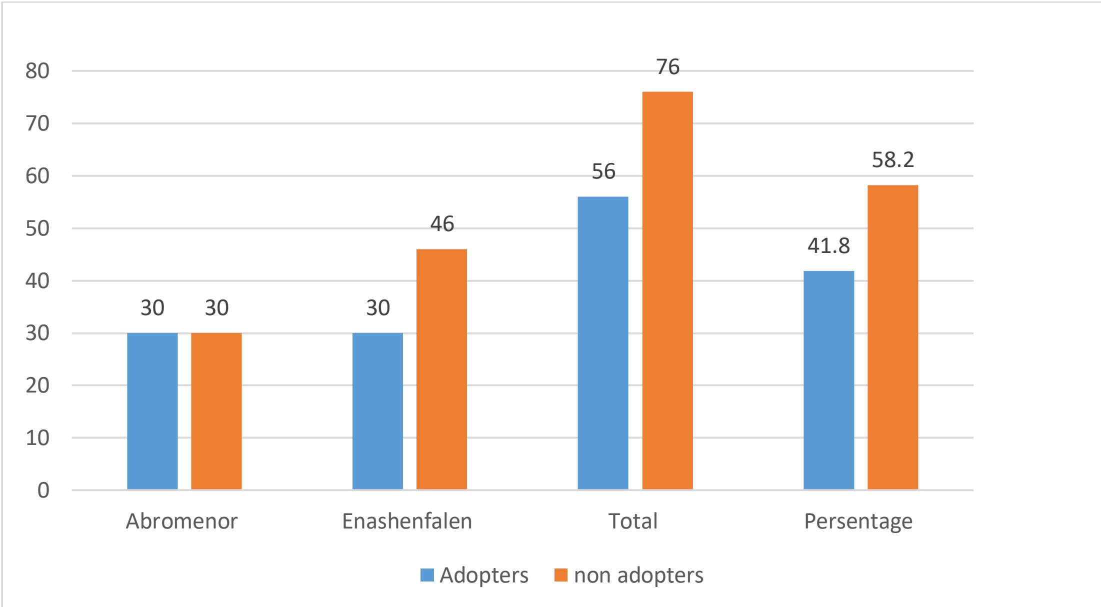
Table 11. Household public campaign participated level

Characteristics	Response	Number (n')	Percent (%)
Participation on public campaign SWC practices	Yes	121	91.6
	No	11	8.4
Participation way	Voluntary	87	65.9
	Without their interest	12	9.09
	With incentive (cash, material…e.g.an axe ,dagger ,)	33	25.01
Constraint to implement SWC technologies (measures)	Difficult to constructing the new introduced measures	13	9.8
	Required more labor	24	18.2
	Physical measures decrease farm land /difficult to digger	32	24.2
	Poor agricultural service	16	12.1
	Poor constriction design	33	25
	Land owners not understand impacts of erosion on crop and koga dam	11	8.3
	Other	3	2.2
SWC measure structures maintained the last five years	Yes	62	46.9
	No	70	53.1

Source: From my survey

4.1.6.5 Adoption status of SWC measures

Out of the total study participants, 58.2% of farmers were non –adopters and 41.8% were adopters. This implies the majority of the HH in the study area implemented less than 50% of the recommended measures that were suitable for their agro-ecologies and/or can't perform maintenance on SWC measures. When compared to kebele to kebele, adoption status in Abromenor kebele is highest as compared to Enashenfalen kebele (graph: 1 shown below).



Graph 1. Percentage of SWC measures adoption stratified by agro-ecology

4.2 Determinants of adoption of SWC

4.2.1 Determinants to implement of SWC measures

In order to determine the adoption of SWC measures there were a total of 16 explanatory variables used from demographic and socio-economic factors, HHH awareness, farm characteristics and institutional factors. The logistic regression output, marginal effect (dy/dx) result, shows that distance to market, HHH awareness to profitability of measures and training on SWC measures were positively significant factors for adoption of SWC measures but the remaining explanatory variables have no significant effect on adoption of measures at 5% significance level. Detailed explanation for each explanatory variable with adoption of SWC measures were shown below (Table 12).

Table 12: logistic model for adoption of SWC measures in Koga watershed

Adoption SWC	*Odds Ratio*	*dy/dx*	*Std.Err.*	*Z*	*P>/z/*	*[95% Conf. Interval]*	
HHSEX	.99678	-.001213	.2717537	- 0.02	0.985	.5824559	1.699332
HHAGE	1.006692	.0011059	.0103522	0.45	0.650	.9846059	1.025189
HHEDU	1.032235	.0070363	.1468843	0.21	0.835	.7790713	1.36237
FAMSZ	.8966297	.0257748	.0647994	- 1.51	0.131	.77821	1.033069
LABAV	1.139071	.0307592	.1501217	0.99	0.323	.8797682	1.4748
OFFRM	1.579301	.0772559	.3704054	1.20	0.231	.8148399	2.3334778
TLU	1.039526	.091345	.0826145	0.49	0.627	.8894867	1.214641
PERSO	1.8771267	0.859754	.4899595	- 0.18	0.938	.5462095	22.748004
LADTE	.8221525	.0468867	.2382037	- 0.68	0.499	.4659424	1.450683
FARLOC	1.003791	.0008939	.0021 1.81	0.07	0.999684	1.007916	
EXTSR	1.096376	.0217043	.2445556	0.41	0.680	.7080956	1.697567
TRAN	1.603305	.3322801	.3753728	2.02	0.044**	1.013279	2.536899
CRDT	.8761325	-.03116	.1903985	- 0.61	0.543	.5722545	1.341375
DMAR	1.455319	.1288637	.1778723	3.07	0.002**	1.145309	1.849243
TLDSIZ	1.016175	.0037904	.1767299	0.09	0.926	.7226541	1.428917
PERTEC	2.741169	.2452351	1.207885	2.29	0.022**	1.155732	6.501513
Cons.	.081464	0651689	. -3.090		0.002	0166561	0.3998815

Number of Obs = 132 **p value < 5%

Wald chi^2 (16) = 28.39

Prob > chi^2 = 0.0021

Pseudo R^2 = 0.0563

Log pseudo likelihood = - 267.38746

***, **, * Indicate significance at 1%, 5% and 10% level respectively

1-The success of prediction of the model based on a 50% probability classification table.

2-Correctly predicted households that implement SWC measures/ adopted regularly based on a 50% probability classification.

3-Correctly predicted households that did not adopted SWC measures based on 0.5 cut point probability table.

Source: Binary Logit Model output

The maximum likelihood estimates of the binary logit model result shows that the sustainability of implement SWC measures in the study area was influenced by different personal, socioeconomic, institutional and biophysical factors.

To check measure of goodness of fit in logistic regression analysis, the likelihood ratio test that follows chi-square distribution can compute the goodness of fit of binary logistic regression (Gujarat, 2003). Accordingly, the chi-square computed result shows that, the model was significant at 1 % significance level. This indicates that the unacceptable hypothesis stating the coefficients of explanatory variables are equal to zero was rejected and the alternative hypothesis of non- zero slope was accepted. And also the Hosmer and lemeshow test can show the goodness of fit of the model to predict the observed data fairly. Based on the test result the model was fitted to the data since the significance level is greater than 0.05 (which is 0.991). Another comparatively simple measure of goodness of fit was the countR^2. Based on this the determinants of SWC measure implementation process can be expressed by parentage and table value with related to the variables. To predict the relationship between SWC adoption and independent variables tested at 5% significance level.

4.2.1.1 Demographic and Socio-economic factors

Demographic and Socio-economic factors explanatory variables including in the model were sex, age, family size, education status, total livestock, labor availability, and off-farm activity of household head. But all demographic and socio-economic characteristic had positive relation with adoption of SWC measures but sex of household it was inversely affects adoption of SWC measures. Whereas, all socio-economic factors did not have significant impact on adoption of SWC measures in this study (Table 12).

Similarly to this study, Zeleke et al., (2018) confirmed that, age, sex, total livestock and education status of household head did not have significant impact on adoption of SWC measure. In differing to this finding, various researches (Asfaw & Neka, 2001; Mekonnen & Abiy, 2014; Teshome, de Graaff, & Kassie, 2016; Mango et al., 2017) reported significant level of socio -economic status on adoption of SWC measures.

4.2.1.2 Farm characteristic

The current study result shows that farm location, farm size and land tenure security were positively associated with adoption of SWC measures but did not had important connotation with adoption of SWC measures in koga watershed. Similar to this study, Fkiru, 2009 reported that land tenure system are insignificant in highland part of Ethiopia because most of farmers were feeling the sense of land ownership since they got land certification but the study conducted by Tefera & Sterk, (2010) in Fincha watershed western part of Ethiopia result shows, land tenure were positively significant to conservation measures. When farmers believe the profitability of conservation measures and also agriculture was the only source of livelihood, farmers' farm size and farm location cannot be a constraint for adoption of SWC technologies. Contrary to this,Amsalu & Graaff, (2006) and Teshome, Graaff, & Kassie, (2016) reported that farmers who hold large farms are more likely to invest in conservation. Also, Gebremedhin & Swinton (2003) reported when increasing farm location from farmers homestead adoption rate should be decreased.

4.2.1.3 Institutional factors

The logistic regression model result shows that, both distance to market and training on SWC measures were significant factors for adoption of SWC measures. Whereas, contradictory to our belief access to credit were negatively, and agricultural extension service there was positively associate with the adoption of SWC measures but had not significant effect with adoption of SWC measures. Agricultural extension service and training on SWC were the basic tools for farmers to get awareness about SWC, the mechanism how to implement it and improve production methods (Asfaw & Neka, 2017). According to key informant interview finding, each *kebele* had total of 2-3 agricultural extension officer and also majority of the household get agricultural extension advice. But the current study result tells that, agricultural extension service was significant variable on adoption of SWC measures. Household head who were attaining SWC measures training were, 33.3 % (0.333*100) more likely to adopt conservation measures than non-trained household, holding other factor constant. According to qualitative data source, agricultural development office provide SWC training for selected farming household head for purpose of guiding public campaign work for their local area and to conserve natural resource for sustainable way. Similarly to this study, there are studies (Mango et al., 2017) which showed significant level of training on adoption of SWC measures. The lack of access to market were one of the factors that were negatively affected adoption of SWC measures due to increased production costs and unsatisfactory profit margins farmers get (Gebremedhin & Swinton, 2003). In opposing to this, the current study marginal effect result shows that when distance to market increase by 1hr, being adopter of technologies was increased by 12.8 % (0.128*100) while other things was held constant . The possible reasons for this could be the presence of only one market for more than 10 *kebeles* farming household for selling and buying agricultural outputs at *Woreda* level. This implies the farming household was suffering to travel long distance to get market access and also these factors may pushed HHH investing their time for managing their land rather than frequently travelled to market. The other possible reason for better adoption of SWC measures in the two agro- ecology zone were slope of land and access to input for physical measures like stone in dega agro ecology zone.

4.2.2 Limited Awareness on SWC on the community

Understanding farmers awareness of soil erosion and its impact is important in promoting SWC measures. This result shows that, majority of the farming HHH perceive soil erosion as a problem on their local area and they recognized high rainfall, deforestation and steepness of the land were the dominated cause of soil erosion. And also, majority of the HHH evaluated soil erosion level decreased through time because of conservation measures but farmers awareness were not significant factors for this study. Similar to this finding, other studies (Jaleta M. *et al.* 2016; Teshome *et al.*, 2016) reported insignificant level of soil erosion awareness. Whereas, farmer perceived about long term profitability of conservation measures was found to have positive relation with adoption of SWC measures and it was statically at 5% level of significant. The marginal effect shows that, conservation measures profitability perceivers HHH were 24.5% (0.245*100) more adopters of SWC than non-profitability perceiver, held all factors were constant. This implies that there is high probability of investing SWC measures to their farm land in the case of the households understanding the long-term outcome of the conservation measures rather than those taking awareness of soil erosion as a problem only. Similarly, study done by Amsalu& Graaff , (2006) showed that there is a significant association of farmers conservation measures profitability awareness with adoption of SWC measures.

But in the survey interview result shown on this study, Less awareness of the nature and technical requirements of SWC practices as well as lack of awareness on agricultural knowledge and SWC measures are the major machinery that have not been developed or introduced in most determinants which are limiting households to adopt and implement SWC practices at their farmlands (86.3%) table 13. Higher education levels are hypothesized to be associated with improved awareness and knowledge regarding conservation measures and the productivity, and effects of erosion may encourage them to choose particular SWC practices (Addisu Damtew, 2011).

Table 13: Determinants to implement SWC practices in koga watershed

Determinants to implementation SWC practices	n'=**132**	
	n'	**%**
Limited awareness on SWC	114	86.3
Land shortage	123	93.1
Labor shortage	105	79.5
Poor resource endowment	90	68.1
Shortage of road infrastructure on SWC practices area	108	81.8

4.2.3 Land shortage

Land shortage was negatively affecting households in the watershed related to adoption of SWC measures (93.1%) table 13. The similar studies was recommended that different measures has different amount of implementation on the farm land. Therefore; fanya –juu occupies 2-15% of the land area for a slope of 3-15%, stone bunds occupy 5-25% for a slope of 5-50% and soil bund occupy 2-20% for a slope of 3-30% (Teshome, 2013) this evidences estimated that stone bunds occupy about 8% of the farmland in the northern Ethiopia. In experimental plots established in the central highland of Ethiopia, soil bund occupies 8.6% of the cultivable land (Adimassu, 2012).

But in the study area labor shortage comes from farm lands or plots are mostly held by older families, youngest farmers have small farm land therefore, these farmers do not participate easily in SWC practices.

4.2.4 Labor shortage

Labor shortage, especially the number of family sizes of the households largely influences the adoption of SWC measures in the watershed (79.5 %). The construction and maintenance of physical SWC structures require huge human labor for developing countries because of them prepare by human physical labor by using traditional Martials like, an axe. This result shows the labor demand appears much more than the requirement for most ordinary farming (businesses). The study revealed that, constriction of soil bunds requires 75 -150 persons per day per hectare, in Debre Mewi and Anjeni watersheds, respectively. In those watersheds, stone bunds required 125 persons per day per hectare and in the Anjeni watershed fanya juu demands 150 persons per day per hectare (Teshome, 2013).

4.2.5 Poor Household Resource Endowment

Wealth statues of the farmers are influencing the decision of households to implement particular SWC measures (68.1%), and water conservation effort because farmers with higher net income are less likely to be financially constrained to adopt SWC measures (Addisu Damtew, 2011). This shows that poor households are not effectively implement SWC measures in their farm land. From the detail interview to understand this in the survey.

4.2.6 Shortage of road infrastructure on SWC practices area

On SWC measures implementation process the community's road infrastructure is out of its function by the working time, due this farmer's dose not interested to practice SWC measures in their plot/farmland. Therefore, Shortage of road infrastructure on SWC practices area (81.8%) is the determinant of well implementing SWC measures on the watershed. During filed observation to understand this Ruther than the survey result shown 81.8% of farm households are saying the main determinant factors of well implement SWC measures in the farm land.

4.2.7 No coordination between stakeholders

In the Koga watershed there is no coordination between stakeholders on effective SWC measures practice. During informant interviews with development agents, woreda environmental protection authority and koga irrigation and watershed management officers there is no collaboration between thus stakeholders in SWC practices. But different study show that collaboration is necessary to effective implementation or practices of SWC measures in the watershed level. Therefore, the dam is easily affected by sedimentation year to year because these stakeholders did not work to reduce determinants on SWC measure implementation in the Koga watershed.

CHAPTER FIVE

5 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This research, which is intended to assess the determinates of implement SWC measures to the existing process of physical conservation practices in koga watershed. Based on the result of the study, the study found that, with the help of the extension services, farmers are implementing various soil conservation measures, on the watershed mainly implemented physical conservation structures are such as terraces and bunds. The major SWC measures being employed in the watershed existed physical SWC measures (stone bund, stone faced soil bund, Check dam and fanya juu terrace), agronomic conservation measures (contour farming, mixed cropping, and crop rotation), and biological conservation measures (afforestation, agroforestry, area closure, and grass strip).

The study shows that different determinates are to influence on the existing adapted strategies of physical SWC measures on the farmers. These are lack of awareness on SWC, land shortage, labor shortage, and wealth status of the farmers and also there is an intuitional were determines of the households level to implement SWC practices on their farmlands due to these year to year the implementation process is highly decreased in watershed

Finally this study indicates that, even if the adopted SWC measures were essential to enhance soil fertility there the reduction of erosion on the farmland and decries sedimentation on the koga dam.

5.2 RECOMMENDATIONS

The Kind of personal, socio-economic, institutional and biophysical determinates would contribute to the design of adopted strategies to achieve practical change in SWC implementation process in the study area and other similar areas of the region and as well as all over the country.

On the foundation of the analysis results and literature reviewed, the following points were made recommendations should be taken in to account.

- The first recommendation is that, farmers need to be encouraged to implement SWC measure through the use of the productive work payments incentive.
- Secondly, we should increase the following period, reducing intensive cultivation in hilly land, integrated use of SWC practices, and extension of micro-irrigation systems could replenish the degraded soil characteristics and improve crop production.
- Thirdly, stakeholders are must be collaboration each other, for example woreda environmental protection authority work together with koga project office because of during filed observation koga project officers are does not envelop in watershed management practices.
- Finally, federal and local governments should support and encourage further studies in the watershed to improve extents of SWC measures ,apply scientifically improved design of SWC measures on the watershed and to reduce the major determinants which are influencing implementation of SWC measures.

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7 Appendixes

Annex 1: Marginal determinates after logistic regression model of SWC measures

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

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

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

Variable	**VIF**	**1/VIF**
1.HHSEX	**1.08**	**0.85435**
HHAGE	**1.29**	**0.83498**
HHEDU		
1	**1.14**	**0.863806**
2	**1.3**	**0.800336**

FAMSZ	**1.51**	**0.706148**
LABAV~e	**1.26**	**0.737414**
1.OFFRM~e	**1.23**	**0.881315**
TLU	**1.43**	**0.710197**
1.PERSO~n	**1.21**	**0.886733**
1.LADTE~e	**1.01**	**0.897016**
FARLOC	**1.21**	**0.903951**
1.EXTSR~e	**1.10**	**0.836728**
1.TRAN~e	**1.15**	**0.861639**
1.CRDT~e	**1.09**	**0.920328**
DMAR	**1.19**	**0.851082**
TLDSIZ	**1.20**	**0.821262**
1.PERTEC~e	**1.07**	**0.934899**

Mean VIF =1.2

Annex 3: Model goodness-of-fit test for adoption of SWC

Logistic model for SWC adoption, goodness-of-fit test

Number of observations =132

Number of covariate patterns = 129

Pearson chi2 (124) = 125.8

Prob > chi2 = 0.3912

Annex 4: Research questionnaires

A QUESTIONNAIRE FOR THE SELECTED KEBELE HOUSEHOLD HEADS IN KOGA WATERSHED.

Dear respondent,

The main objectives of this questionnaire are used to assess determinants of soil and water conservation practices to implement effective SWC measures in koga watershed. To the partial fulfillment of MSc. Water resource management study program. Household head is the respondent of this questionnaire. Your responses to the questions are valuable and will be held in highest confidentiality to be used only for the analysis of this research. In this Study, you and I would have a short discussion of about 15-30 minutes only and I am asking you to help us. You will not be identified by name in any case. If you accept to participate in this research, you will be doing so voluntarily and there will not be any monetary returns.

Endeshaw Addisu, Addis Ababa University, 2018/19

Code No.:______________________ Name of data collector: ___________

Kebele_______________________ Date: ____________

1. General information

Farmers survey identification: ____

Interviewer: ____

Date of interview____

Checked by: ____

Date checked: ____

1.1 Respondent name____

1.2 Sex: 1) Male 2) Female

1.3 Age________years

1.4 Marital status: 1) Single 2) Married 3) Divorced (separated)

1.5 Kebele 1. Enamrit 2.Andinet3.Kudimi4.Rim5.Kurt-Bahir 6.Midre-Genet 7. Abiyotufana

1.6 Strata 1. Upstream 2. Down stream

1.7 Distance to woreda market__________ (in hour)

1.8 Social position in the kebele

1) Member of kebele council 2) Religious leader

3) Others, specify_____________________ 4) none

1.9Education level_______________grade

2. Household Characteristics

2.1 Household family members' information

Sex

Male__________ (No),

Female____________ (No)

Age

0-15yr_________ (No),

16-64yr__________ (No),

Greater than 64 ________ (No)

Education

0 grade______ (No),

1-4______ (No),

5-8_________ (No),

9-12_____ (No),

Diploma graduate____ (No),

B.Sc degree________ (No),

3) Landholding and farm characteristics

_____(No)

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

4. Description of farm plots

Code: 1. Cultivated 2. Grazing 3. Forest 4. Home-stead 5. Cultivated – Home stead 6. Grass – Home stead 7. Grass – forest 8. Forest – Home stead 9. Cultivated - Forest

	Description	Plot 1	Plot 2	Plot3	Plot 4	Plot 5
1	Area of the Plot (ha)					

2	Types of major crops grown **1**=Teff**2**=Barley**3**=Wheat **4**=Rough Pea **5**=Chick pea **6**=Maize**7**=Sorghum **8**=Horsbean**9**=Field peas**10**=Rice **11**=Triticale**12**=Noug**13**=Onion**14**=Tomato**15**=Potato 16=Millet, **17** others, Dagusa, **18**. NA**19**. 1& 6 **20**. 6 & 17**21**.1, 3 &6**22**. 6, 7&17 **23**. 1, 6 & 17**24**. 1 & 17					
3	Fertilizer use (in Kg)					
4	Labor (lMDs) per average in annually					
5.	Traction (oxen)					
6.	Yield (in Kg)					
7.	Seed type 1= local seed, 2= improved 3.NA					
8.	Seed quantity (in Kg)					
9.	Manure (in kg)					
10.	other chemicals (in liters)					
11.	Distance from home (walking minutes)					
12.	Slope: 1) Flat (0-6%) 2) Gentle slope (6-15%) 3) Steep slope & Mountainous (> 15%)					
13.	Plot fertility: 1) high 2) medium 3) low					
14	Source of the plot 1) inherited 2) received from kebele 3) rented in 4) other ____ (specify)					
15	Source of the plot 1) inherited 2) received from kebele 3) rented in 4) other ____ (specify)					
16	Color of the soil 1) red 2) black 3) brown 4) sandy 5) 2 & 4					
17	Degree of erosion problem on the plot 1) high 2)medium 3)low					

18	Number of years since the plot is used					
19	Irrigated 1) yes 2) no					
20	Presence of at least one type of improved Conservation structures 1) yes 2)no					
21	Physical Improved soil and water conservation structures built in meter or No Soil terrace Cut off drain Fanya juu Planting of d/t trees in No Others, specify					
22	Who constructed the structures? 1) Community participation 2) Family (hired) labor 3) Financial incentives by government 4) labor exchange 5)NA					
23	Do improved soil and water conservation structures maintained or not 1)yes 2)no 3) NA					
24	Who did the maintenance work? 1) Community participation 2) Family 3) hired labor 4) Labor exchange 5. NA					
25	Status (degree) of use of improved soil conservation structures (practices) 1) Removed totally; 2) Partially removed 3) Not removed; 4) Modified (adapted) 5) NA					

	Traditional soil and water conservation structures built (in meter) 1.Traditional stone bund					
26	2.Traditional ditches 3.Trash (garbage) lines 4. Cut off-drain 5. Plantation 6. Others, specify					
27	Total LMDs for conservation per annually					
28	Total LMDs for maintenance per annually					
29	How do you perceive the soil depth of your plot since you owned it? 1) increased 2) decreased 3) no change 4) I do not know					
30	How do you compare the problem of soil erosion in Your farm plots after watershed management practices were built? 1) aggravated 2) reduced 3) no change 4) I do not know 5) NA					

5. Labor Availability

5.1Do 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 (Koga)
3) Others, specify_______________ 4) NA 5) 1 &2
5.3 If labor is hired, what type of labor do you hire?

1) Casual 2) permanent 3) both 4) NA
5.4 Can you easily get labor whenever you need? 1) Yes 2) No 3) NA
5.5Which family members participate in watershed management works?
1) Men 2) women 3) Children 4) all of them participate
5.6 Do you or your family member work on off – farm activities? 1) Yes 2) No
5.7 If the answer to question 5.6 is yes, fill in the following table for 2010 E.C

No	Types of off-farm (non- farm) activity	Total income obtained
1.	Petty trade	
2.	Pottery	
3.	Weaving	
4.	Leather making	
5.	Selling of fire wood	
6.	Labor hire out	
7.	Transportation by "Gary"	
8.	None	

5.8 If answer for #5.7 is from 1-7, Which Family members working non-farm activity?
1) Men 2) Women 3) Children 4) All

6 Perception of soil erosion problems

6.**1Do you think that soil erosion is a problem for your farm plots?**
1) Yes 2) no
6.2 Give rank to the following major causes of soil erosion in your area?
1) Deforestation ____________
2) Over grazing ____________
3) Over cultivation _________
4) Poor agricultural practices ________
5) Cultivation of steep slopes _______
6) Excess rainfall _________________
7) Poor government polices _________
8) Others (specify) ___________________
6.3what do you think is the consequences of soil erosion?

1) Land productivity (yield) decline 2) Change in type of crops grown
3) Reduces farm plot size 4) all 5) 1&3 6) others (specify) ________

6.4 Farmers' perceptions of soil erosion hazards

Perception on erosion	Proportion of total respondents (%)
1. Whether soil erosion was perceived as a problem in own farm	
Yes	

No ____________	
2. Severity of the problem, if yes to the above question	
Severe Medium Moderate____	
3. Observed change in soil erosion severity over the past 5 years	
Has become more severe Has become less severe No change________________________________	
4. Extent of impact of soil erosion on farm production	
Severe Moderate Has no effect ____________	
5. Believing that soil erosion can be controlled	
Yes No _____________	

7. SWC Measures and Farmers' Attitude

7.1 Do you know the existence of improved soil and water conservation structures?
1) Yes 2) No

7.2 If yes, which type do you know?
1) Stone bunds 2) Soil bund 3) Cutoff drain 4) Water way 5) Fanyajuu 6) Planting of d/t tree 7) NA **8)** 1,2,3&4 **9)** 1,2,3,4&6 **10)** 1,2,4&6 **11)** 3,4&6 **12)** 1,2 &6 **13)** 1,3 & 6 **14)** 1,2,3&6

7.3 If yes, what is your source of information?
1) Neighboring farmers 2) Extension agents (DAs)
3) NGOs 4) from field days and Trainings
5) others, specify_________6) NA 7) 1, 2 & 3 8) 1 & 4

7.4 Which of the following types of SWC measurers are efficient to reduce the problem of soil erosion?
1) Stone bund 2) Soil bund 3) Cut off drain 4) Water way
5) Fan -ya juu 6) Planting of d/t trees 7) NA 8) 1,2,3,4
9) 1, 2, 3, 4, 6 10) 1,3,4,6 11) 3,4,6 12) 1,2,613) 1,3,6 14) 1,2,3,6

7.5 Have you participated in community conservation activities this year?
1) Yes, 2) No

7.6 Did you undertake the maintenance work by your own?
1) Yes 2) No

7.7 If no, what were the reasons for not doing?
1) I have shortage of labor 2) Lack of skill and knowledge
3) Conservation structures were built without my knowledge and willingness
4) I expect the land will be transferred to other farmers
5) There was no need for maintenance 6) 1, 2 & 4 7) all 8) NA

7.8 Do you believe that investment in watershed management practices is profitable in the long run? 1) Yes, 2) No

7.9 If the farmer did not use any improved conservation structures in all his plots, why you did not use it?

1) No problem of soil erosion
2) Shortage of labor
3) Expecting that the structures will be done by financial incentives
4) I feel that the land belongs to the government and it is the duty of the government to maintain the land
5) it reduces farmland
6) Due to problems of rodents and others pests
7) I did not get extension service
8) Others, specify 9) NA

7.10 What are the problems related to each SWC structures?
Hint, choose from 1-5

Problems	Soil bund	Cut off drain	Water way
1. Source of rodents 2. Reduce farm land 3. Difficult to turn oxen 4. Labor intensive 5. Difficult to implement (technically) 6.costly			

Code: 1) 1, 4, 5 **2)** 1, 4, 6 **3)** 2, 4 **4)** 3, 4 **5)** 2, 4, 6 **6)** 2, 3 **7)** 2, 3, 4 **8)** 1, 3, 6 **9)** 1, 2, 6 **10)** 1,2,3,6 **11)** 4, 5, 6 1**2)** 2, 6 1**3)** 1, 2, 3 **14)** 2,3,4,6

8. Tenure arrangement

8.1 Whom do you think land belongs to?
1) My own 2) the government 3) Other____________

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 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 4) NA

8.7 Are your plots all registered? 1) Yes 2) No

8.8 If yes, did you get certificate for all plots? 1) Yes 2) No 3) NA

9) Institutional Support

9.1 Do you get extension service? 1) Yes 2) No
9.2 If yes, who provides the extension service?
1) Development agents (DAs) 2) NGOs 3) All 4) Others, specify ___
9.3 How often you have been visited by DAs last year?
1) Once per month, 2) Twice per month,
3) Three times per month 4) others, specify-__________________
9.4 How often you have obtained extension advice on soil and water conservation practices
1) Once per month 2) twice per month
3) Three times per month 4) Once per three months
5) Twice per three months 6) others, specify____________________
9.5 Have you participated in training of watershed management practices for the last five years?
1) Yes 2) No
9.6 If yes, for how many days? __________days.
1) Many 2) NA
9.7 Was the training useful?
1) Yes 2) No 3. NA
9.8 Do you participate from access of Credit?
1. Yes 2. No

10) Wealth status of the respondents

No	Type of livestock	Number
1.	Ox	
2.	Cow	
3.	Calve	
4.	Heifer	
5.	Horses	
6.	Mules	
7.	Donkey	
8.	Goats	
9.	Sheep	
10.	Chicken	

10.1 Livestock
10.2 What are the main sources of feed?
1) Grazing 2) Hay 3) Straw 4) Maize and Sorghum Hola 5) 'Atela' 6) All 7) NA
8) 1, 2, 4 **9)** 1, 4 **10)** 1,3,4,5 **11)** 1, 4 5 **12)** 1, 3, 6 **13**) 1, 3, 4
14) 1, 2, 3 **15)** 1, 3, 5 **16)** 1, 3 **17)** 1, 2
10.3 How pasturelands are owned in your area?
1) Individually 2) Communally 3) Both 4) Others_______ 5) NA

Annex 5: Focus group discussion checklist

Focus Group Discussion for famers

1. What are soil and water conservation/ watershed management practices you have been using to increase your production?
2. What are the criteria that you use to select soil and water conservation/ watershed management practice?
3. What are the major livelihood strategies in your area?
4. Do you really believe that soil and water conservation/ watershed management has impact on the livelihood of the community?
5. What are the main constraints and opportunities regarding to soil and water conservation/ watershed management practices?
6. Does your community believe watershed management practices are important or not? Explanation

Annex 6: key informant checklist

Structural survey questionnaire for formal interviewer, ***Interview for Koga irrigation and watershed management and Woreda /Kebele development agent officers.***

Key informant Interview

1.What are the major types of SWC practices in this woreda---------,------------,

2.What are the major types of soil and water conservation /watershed management can implement in koga watershed--------------,---------------,------------------------

3.What are indigenous SWC practice do the local community practice on different land use i.e. crop land, forest, grazing, rangeland?

4.What are the constraints regarding to traditional SWC practice?

5.By what criteria does the local community select each SWC practice?

6.What are modern SWC measures are practices implemented in your area?

7.Is the implementing SWC measure type scientific? if you say **yes** during practices time ,what are the positive and negative side of the implementing on the community………

8.How do you describe SWC practice regarding reduction in soil erosion, crop production, forest conservation, water availability, and forage and income diversification rather than these about koga dams?

9.Is there any wildlife coming to their original home due to implementing SWC measure practice that migrates due land related problems? If **yes** please list ……

10. Is there any challenge during implementing SWC in the Koga watershed? List them ………………………………………………………………………………

11. What do you think is the challenge for effective SWC practice and also what are the best remedies?

12. Are there any gaps in the community in SWC implementation/practices Time? Please list them ……………………………..
13. What are the sources of inputs required for SWC?
14. Do you/farmers feel land ownership? Please explain
15. Was a public participation plan developed for the watershed planning process?
16. Tell me about the opportunities for public involvement during the SWC planning process?

Annex 7: Observation checklist

A. Physical Environment (Implemented SWC practices, slop, soil type, koga dam etc.)

B. Infrastructures (Road, credit institute, light, drinking water supply, market, transport, health center access etc.)

Annex 8: Secondary Data Collection Format

1. Total size of koga watershed land ____________hectar.

A. Cultivated land ___________

B. Woodlot area_____________

C. Grazing area_____________

D. Bare land______________

2. Soil type and major crop type

3. Farming system

4. Slope of the land

5. Rainfall amount

6. Main occupation

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CDS Approval   signature   date

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the college of development studies (CDS) through the center of environment and development studies of the candidate's department.

Stamp of CDS   date --------------------------