ASSESSMENT OF ADOPTION BEHAVIOR OF SOIL AND WATER CONSERVATION PRACTICES IN THE KOGA WATERSHED, HIGHLANDS OF ETHIOPIA

A Thesis

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By

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ABSTRACT

Land degradation is one of the major challenges in agricultural production in many parts of the world, especially in developing nations like Ethiopia. Even though a number of soil and water conservation methods were introduced to combat land degradation, adoption of these practices remains below expectations. This research was conducted in the Koga watershed, near Lake Tana, in the catchment of a recently constructed dam. It aimed to examine farmers' views on land degradation and to assess their adoption behavior of soil and water conservation knowledge.

Structured questionnaire survey and focus group discussion methods were applied to collect the necessary information from farm households. A total of 100 households were interviewed and 282 plots and several fields were visited during transect walks. The Tobit regression model was used for analyzing correlations among area, household, plot characteristics and the adoption of three types of soil and water conservation practices. In addition, data were analyzed using descriptive statistics and cross-correlation methods.

The results show that total area of plots, age of household head, education of household head, total number of livestock and distance to market from household home are among the major factors that positively and significantly influence adoption of soil and water conservation measures. Greater distance from home to farmland, smaller land to labor ratio and larger family size are factors that decreased adoption. The data showed in addition that more soil/stone bund terraces were implemented on steep land. Unlike in other studies in the region, sex of the household head did not seem to make a difference in adoption of three different SWC practices.

BIOGRAPHICAL SKETCH

The author was born in South Wello Administrative zone, Amhara-Sayint Woreda (580 km Northern from Addis Ababa, capital city of Ethiopia) in June 07, 1984. He attended Sayint Elementary and Junior Secondary School and completed his secondary school education at Dubti (Afar Region) and Sayint (Amhara region) Senior Secondary School. Then he joined Debub (currently Hawassa) University in September 2002 and graduated with a BSc degree in Agricultural Resource Economics and Management in July 2006.

Following his graduation, from July 2006 to September 2006, he served as Watershed Management Expert in an Operational Research Project (joint NGO & Government project) in Hawassa University, SNNPR.

Finally in October 2006, he was employed by Mehal-Sayint Woreda Agricultural and Rural Development Office as an agricultural credit and input supply expert and worked there until he joined Cornell University at Bahir Dar University to pursue his Master of Professional Study (MPS) degree in International Agriculture and Rural Development with a specialization in Integrated Watershed Management and Hydrology in September 2007.

To my lovely mother W/o ***Abesha Tadese*** *and my father Ato* ***Assefa Mengstie --*** *they are still fresh in my memory and deserve great credit for my current achievement.*

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ACTRA	Access to training
AGEHH	Age of household
ATLND	Area of total farmland
BSc	Bachelor of Science
DA	Development agent
DAP	Diammonium Phosphate
DIMAR	Distance to market
DIST	Distance to the plot
EDUHH	Education of household
EOTC	Ethiopia Orthodox Tewahedo Church
ETB	Ethiopian birr
EXT	Extension
FAO	Food and Agricultural Organization
FFW	Food for work
GDP	Gross domestic product
GNP	Gross national product
ha	Hectare
HH	Household
ICOFD	Improved cut-off drain
ISOB	Improved soil/stone bund
Km^2	Kilometer squared
LMTs	Land management technologies
LNDLBR	Land to labor ratio
LNDSECU	Land security
masl	Meters above sea level
mm	Millimeters
MCM	Million cubic meters
MoARD	Ministry of Agricultural and Rural Development
MPS	Master of Professional Studies
MS-Excel	Microsoft Excel
N	Number of observations
NGO	Non-governmental organization
^oC	Degrees Celsius
OFINCOM	Off-farm income
PAs	Peasant associations
PERCP	Perception of farmers
PLTRE	Plantation of trees
PSNP	Productive Safety Net Program
RF	Rainfall
SEXHH	Sex of head of household
SLOP	Slope
SNNPR	Southern Nations, Nationalities, and Peoples' Region

SOCIAL	Social position
SPSS	Statistical Package for Social Sciences
SWC	Soil and water conservation
TLS	Total livestock
TLU	Tropical Livestock Unit
TOFAM	Total family size
TOL	Tolerance level
VIF	Variance Inflation Factor
WFP	World food program
%	Percent
m/ha	Meters per hectare
No/ha	Number per hectare

CHAPTER ONE

1. INTRODUCTION

1.1 Background

The backbone of the agrarian economy in most developing countries is rain fed agriculture. The economic development of developing countries depends on the performance of the agricultural sector, and the contribution of this sector depends on how the natural resources are managed. Unfortunately, in the majority of developing nations, the quality and quantity of natural resources are decreasing resulting in more severe droughts and floods. Effective integrated watershed management can reduce these effects.

Ethiopia is one of the poorest countries in the world (World Bank, 2003). Its economy is based mainly on agriculture providing employment for over 80% of the labor force which accounts for a little over 50% of the GDP (Gross domestic product). In fact, agriculture in Ethiopia is not only an economic activity but also a way of life for which agricultural land is an indispensable resource upon which the welfare of the society is built. The livelihood of the vast majority of the population depends directly or indirectly on this sector. Such dependence obviously leads to increased vulnerability of the economy to problems related to land degradation (Wegayehu, 2003). Most farmers are poor and operate at subsistence level, and investment for intensification of agriculture is not well developed in the country. This has created a vicious circle of low productivity - land degradation reduces the production potential of the land and this, in return, makes it difficult for farmers to produce enough and invest in protecting the land. Although land provides a means of livelihood for the majority of the population, land resources are facing increasing degradation mainly due to erosion (FAO. 1986).

Land degradation in the form of soil erosion, sedimentation, depletion of nutrients, deforestation, and overgrazing - is one of the basic problems facing farmers in the Ethiopian highlands, and this limits their ability to increase agricultural production and reduce poverty and food insecurity. The integrated process of land degradation and increased poverty has been referred to as the "downhill spiral of un-sustainability" leading to the "poverty trap" (Greenland et al., 1994). The immediate consequence of land degradation is reduced crop yield followed by economic decline and social stress.

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

Recognizing land degradation as a major environmental and socio-economic problem, the government of Ethiopia has made several interventions. As a result, large areas have been converted to terraces, covered by soil bunds, closed by area closures and planted with millions of tree seedlings. Nevertheless, the achievements have fallen far below expectations. The country still loses a tremendous amount of fertile topsoil, and the threat of land degradation is broadening alarmingly (Teklu and Gezahegn, 2003). Of the various interventions, extensive conservation projects are carried out with the support of the WFP (World Food Program) (Shiferaw and Holden, 1998). One of these is the PSNP (Productive Safety Net Program), implemented in the study area, that provides farmers with grains (FFW, Food for Work) or cash payment for their participation in the funded conservation works. Rural communities living in highly degraded and drought prone highland areas such as highlands of the Koga watershed are involved in SWC (soil and water conservation) activities in the form of FFW under the PSNP. Farmers are initially obligated to participate in the construction of conservation structures because this is undertaken through group labor. Such projects funded by the WFP have, however, been criticized for achieving limited success in addressing the problem. Although food aid has helped to fight hunger in famine-stricken areas, it has not been successful in improving soil and water conservation in the long run (Amsalu and de Graaff, 2004).

Many of the projects sponsored by both the government and WFP were also criticized for putting emphasis only on structural conservation measures, most of which were unfamiliar to the farmers. The farmers were virtually considered ignorant of soil and water conservation practices and were largely excluded from the planning, implementation, and evaluation of these conservation measures (Azene, 1997). Only rare attempts were made to include indigenous experience and knowledge (Amsalu, 2006).

The adoption of improved SWC technologies in developing countries has attracted much attention from scientists and policy makers mainly because land degradation is a key problem for agricultural production (De Graaff *et al.*, 2008). According to De Graaff *et al.* (2008), there are three phases in the adoption process: the acceptance phase, the actual adoption phase and the final adoption phase. The acceptance phase generally includes the awareness, evaluation and the trial stages and eventually leads to starting investment in certain measures. The actual adoption phase is the stage whereby efforts or investments are made to implement SWC measures on more than a trial basis. The third phase, final adoption, is the stage in which the existing SWC measures are maintained over many years and new ones are introduced on other fields used by the same farmer.

The most important reason for limited use of SWC technologies is farmers' low adoption behavior[1]. Kessler (2006) considers SWC measures fully adopted only when their execution is sustained and fully integrated in the household's farming system. Adoption of SWC measures does not automatically guarantee long-term use. For example, when SWC measures have been established with considerable project assistance, not all farmers may continue using the measures. Therefore, introduction of SWC technologies may not lead to sustained land rehabilitation unless the farmers proceed to final adoption.

Previous studies show that various personal, economic, socio-institutional and bio-physical attributes have influential roles in farmers' decisions about the adoption of SWC measures in different areas of Ethiopia. This relationship between attributes has not yet been studied in the Koga watershed in the highland of Ethiopia. Appropriate understanding of these factors in the Koga watershed would assist in the formulation and implementation of the policy interventions designed to induce voluntary continued use of SWC measures.

Because local farmers ultimately determine the use of SWC measures, clear knowledge of the local factors that determine farmer decisions is an essential part of combating severe soil erosion. Whether these factors, widely present throughout Ethiopia, have similar roles in areas where the PSNP is implemented like Koga

[1] "Adoption behavior" refers to the degree to which farmers are intrinsically motivated to maintain and replicate SWC measures. The highest degree of adoption is when farmers are convinced themselves, not by incentives or by statements from others that a measure actually works.

watershed, however, is unexplored. Some subsistence farmers in the Koga watershed are hesitant to accept different measures such as terracing, check dam construction and gully planting, and cut-off drains (Wubneh, 2007). These farmers may not believe that these measures are effective, or they may have socio-economic challenges that restrict use of the specific promoted SWC technologies.

The purpose of this research is, therefore, to contribute to the understanding of the factors that influence farmers' decisions on the adoption of SWC in the Koga watershed study area. The objectives of the study were: to assess the adoption behavior of farmers for different SWC practices; identify personal, socio-economic, institutional and biophysical factors that may influence farmers' participation in those conservation activities; and lastly evaluate the strength of correlations between adoption behavior and different influencing factors.

The study area is in the Koga Irrigation and Watershed Management project, located in the watershed of the upper Blue Nile. This project, supported by the African Development Bank (ADB) and the Ethiopian government, has a 7000 ha command area intended for the cultivation of profitable and environmentally friendly crops to enhance food security. Besides protecting land for agriculture, there is an extra incentive to decrease erosion in the watershed: extending the project's irrigation reservoir life.

Information obtained from this research can aid policy makers, the world community, individual farmers, researchers and extension staff to enhance the adoption of SWC measures in the Koga watershed and other areas with conditions similar to Ethiopia.

CHAPTER TWO

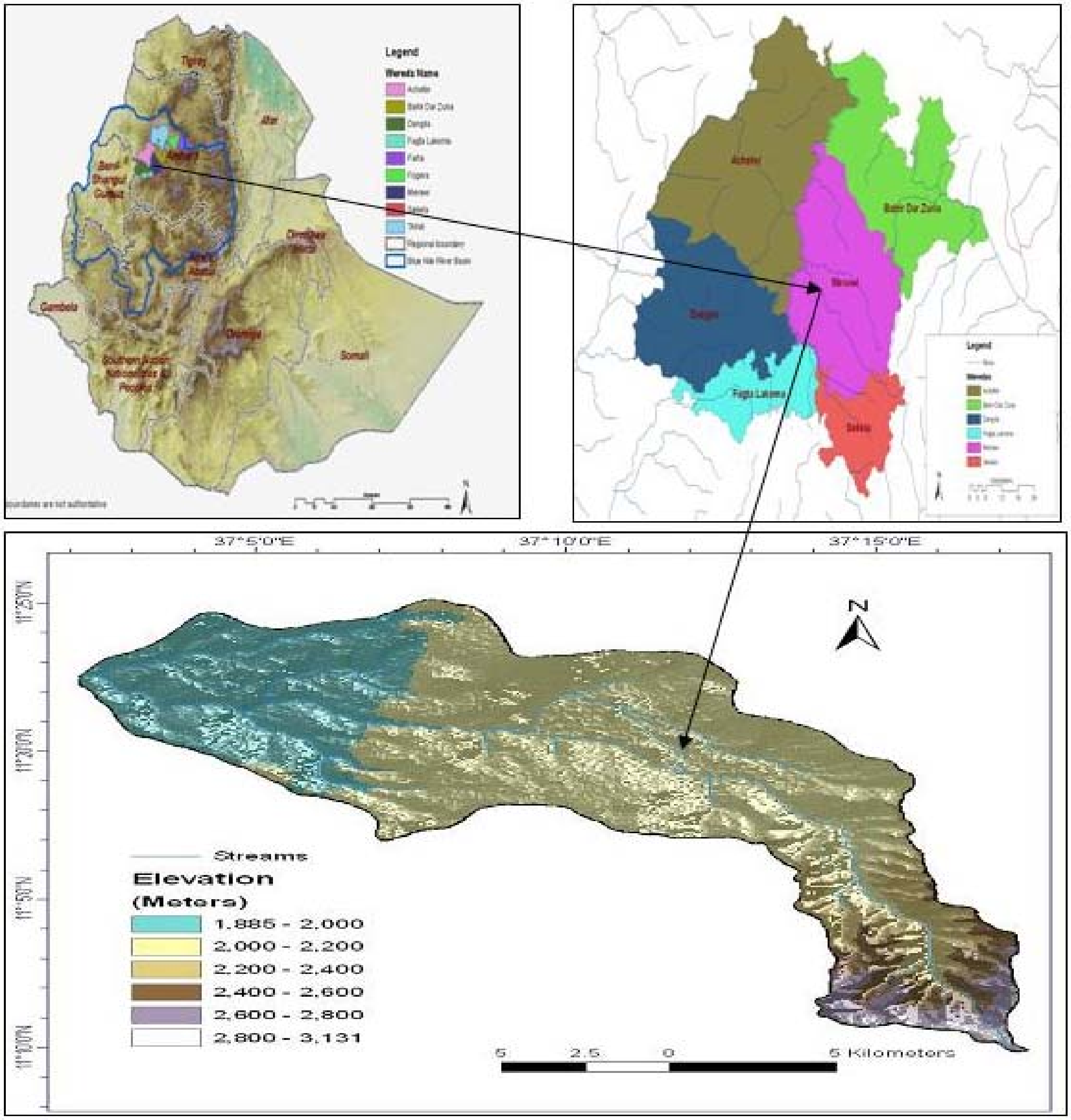
2. MATERIALS AND METHODS

2.1 Study area

The study was carried out in the Koga watershed (Enamirt, Rim, Kurt-Bahir, Andinet, Kudmi and Midre-Genet villages). It is located between 11^0 10' and 11^0 25' North latitude and 37^0 2' and 37^0 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 1). 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^{o}C. The elevation ranges between 1885-3131 masl (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 watershed. This together with increasing population pressure has forced farmers to constantly cultivate new and more marginal areas.



Source: From Aster and Seleshi, 2009

Figure 1: Topography maps of Ethiopia, Mecha Woreda and Koga Watershed, in the highlands of Ethiopia

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.

2.2 Methods of data collection

The data used for this study were obtained from both primary and secondary sources. The primary sources mainly related to adoption behavior were collected using both formal and informal survey methods. All the necessary quantitative data required for the study were gathered through a farm household survey conducted from June to October, 2008. At the beginning stage of the survey, informal meetings were undertaken with a group of farmers in order to understand the general agricultural and socio-economic situation of the population of the study area. Also, informal meetings with key informants (farmers, elder people, researchers, women, experts and development agents) were held to gain in-depth knowledge about the area and to pre-test the farm survey questionnaire. Almost all survey questions (Appendix 3) were closed-ended. These questions were pre–tested with selected respondents. Subsequently, on the basis of the results obtained from the pre-test, necessary modifications were made to the questionnaire, which was ultimately translated from English into the local language, Amharic. The interviews were conducted in Amharic.

In addition to informal contacts, transect walks across each village were conducted in order to obtain all the necessary physical information and determine the questions that need to be included in the survey. It was a useful technique to characterize and understand biophysical and terrain features such as topography, erosion status, and types of traditional and improved SWC practices, land uses, soil type, slope characteristics and soil depth of the area. During the transect walks, informal discussions with villagers helped to acquire useful and detailed information which would have been difficult to collect through the questionnaire survey.

For the detailed personal interviews, a random sampling technique was used to select a total of 100 households (HHs) from among 1260 HH farmers participating in the agricultural activities in the study area. The sampling was done using a list of all households in the villages which was obtained from the representative village administrations and local development agents. A structured questionnaire was used for the interviews, which were conducted both in the homestead and on the farm land. To develop the farmer's trust in the interviewer, each farmer was well informed about the purpose of the survey and why he/she was chosen for the interview.

Data generated from the interview included types of SWC measures (traditional and improved) adopted by the farmer, their extent and their effectiveness. In addition, the personal, socio-economic, institutional and biophysical factors affecting adoption of SWC practices were obtained.

Three enumerators (interviewers) were selected based on their understanding of farming and SWC practices and their educational level. One day of intensive training on how to conduct interviews and record information in the questionnaire properly was given by the corresponding main researcher. Subsequently interviews were conducted by the three enumerators and the corresponding main researcher with every interview done together. At the end of the formal survey in each village, discussions were held by the researcher and the three enumerators with key informants including community leaders, elders, women farmers and development agents. This informal technique helped to acquire useful and detailed information about biophysical factors and farmers' perceptions. Secondary data from literature (scientific and non-scientific reports and unpublished material, proceedings and statistical abstracts) and offices of Agriculture and Water Resources at Regional, Zonal and Woreda level were used as additional sources of information. These data from informal local discussions and secondary sources were used to verify and supplement the quantitative results from the structured questionnaires.

2.3 Methods of Data Analysis

To analyze factors affecting adoption of soil and water conservation technologies 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 perception 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.

To accomplish the analysis at the plot level, the data acquired for each plot were analyzed using descriptive statistical techniques and econometric analysis (Tobit regression model) provided by the Statistical Package for Social Sciences (SPSS). MS-Excel was used to generate tables. For the informal key informant interviews and field observation notes, a qualitative analysis was used.

2.3.1 Specification of the statistical model

Farm households in Koga watershed differ in the proportion of cultivated land on which different types of soil and water conservation structures are used. There are non-users of these improved and traditional soil and water conservation (SWC) measures even in the places were they are promoted. Because some households are non-adopters of SWC practices, the reported proportion of land with SWC for such households is equal to zero. As noted in Greene (2000), a dependent variable that has a zero value for a significant fraction of the observations requires a censored regression model (also referred to as a Tobit model) because standard OLS regression "fails to account for the qualitative difference between *limit* (zero) and *nonlimit* (continuous) observations." Thus, analysis of the determinants of the adoption of SWC requires the application of a censored regression model. Censored regression is preferred because it uses data at the limit as well as those above the limit to estimate regression.

Following Maddala (1997), the Tobit model can be derived based on defining a new random variable y^* that is a function of a vector of variables x as:

$$y_i^* = \beta' x_i + \varepsilon_i,$$
$$y_i = 0 \text{ if } y_i^* \leq 0, \quad \text{……………………………………………………Equation (1)}$$
$$y_i = 0 \text{ if } y_i^* > 0,$$

where y_i is the observed (limited, censored) dependent variable, y_i^* is a latent variable that is not directly observable, x_i is a vector of factors affecting y^*, β_i is a vector of unknown parameters, ε_i are residuals that are assumed to be independently and normally distributed with mean zero and constant variance, $\sigma^2$and i is the index of the observed values from 1, 2 …n. The above model follows many previous analyses (Amemiya, 1985) in that it assumes censoring at 0 (although other values are possible) and that the error terms are normally distributed.

The model parameters are estimated by maximizing the relevant log Likelihood Function of the following form:

$$\log L = \sum_{y_i>0} -\frac{1}{2}\left[\log(2\pi) + \log\sigma + \frac{(y_i - \beta' x_i)}{\sigma}\right] + \sum_{y_i=0} \log\left[1 - \Phi\left(\frac{\beta' x_i}{\sigma}\right)\right] \quad \text{..........Equation (2)}$$

Where L is the Likelihood Function and Φ is the cumulative normal distribution function. Alternatives to the Tobit model (such as Censored Least Absolute Deviations; Nicholson et al, 2004) have been used to address potential issues with heteroskedasticity in household data, but this is beyond the scope of this research.

The marginal effect on y (the observed variable) of a change in an explanatory variable x differs from the value of the β coefficient in the censored regression model. The marginal effects are a function of the x values, and are given by:

$$\frac{\partial E[y_i \mid x_i]}{\partial x_i} = \beta \cdot \Phi\left(\frac{\beta' x_i}{\sigma}\right) \quad \text{,...Equation (3)}$$

Where Φ is the cumulative normal distribution function. Often these marginal effects are calculated and reported at the mean values for the vector *x*, although in principle they could be calculated for individual households. McDonald and Moffitt (1980) proposed a useful decomposition of these marginal effects, because a change in the *x*'s has two different effects. One is that *x* affects the conditional mean of y_i^* in the positive part of the distribution. However, *x* also affects the probability that the observation will fall in that part of the distribution. Expressed mathematically, this decomposition is as follows:

$$\frac{\partial E[y_i \mid x_i]}{\partial x_i} = P[y_i > 0]\frac{\partial E[y_i \mid x_i, y_i > 0]}{\partial x_i} + E[y_i \mid x_i, y_i > 0]\frac{\partial P[y_i > 0]}{\partial x_i}, \quad \text{(Equation 4)}$$

Where *P* indicates probability. Both the marginal effects and their decomposition will be reported for this study.

2.3.2 Hypothesis of Variables

A farmer's decision about SWC practices can be conceived of having two components: whether to use SWC practices and, if so, how many practices to use on how much land. Both of these components are assumed to be influenced by a number of factors that are related to a farmer's objectives and constraints. The dependent and independent variables employed in this analysis are listed below. The independent variables are hypothesized to influence the use of soil and water conservation measures positively (+), negatively (-), or both positively and negatively (+/-). The sign of the parameter coefficient for variables in the last category will depend on the relative strengths of the different effects, and will be indeterminate *a priori*.

The dependent variables (Y_i) represent the SWC practices in each plot and are represented by the length of the soil and stone bund constructed (m/ha), the length of the improved cut-off drain (check dam) constructed (m/ha) or number of trees (No/ha). A similar classification was used by Wubneh, (2007). In principle, one could conceive of farmers making decisions about these practices concurrently, but in this analysis they are assumed to be independent decisions.

The independent variables (X_i) represent factors at both the HH and plot level. For the HH level: age of the household head (years), education of household head (years), off-farm income (birr), livestock holding of the household (number), extension service (1 if the farmer has recently received extension service, 0 otherwise), social position of the household head (1 if the household head has a social leadership position in the kebele, 0 otherwise), perception of the household head about soil erosion problem (1 if the household head perceives soil erosion is a problem on his farm, 0 otherwise), security of land tenure (1 if the farmer considered that he/she will be able to use the plot at least during his/her life time, 0 otherwise). At the plot level, the variables include: area of total cultivated land (ha), ratio of total land to labor (hectare per person days), walking distance to the farm plot from home (minutes), slope category of a plot (1 flat; 0 otherwise).

Table 1 classifies the independent variables into four groups: household demography, household economics, institutional aspects and biophysical factors (Table 1).

Table 1: Classification of independent variables

No	Variable group	Individual variables
1.	HH Demography	Age, Education, Gender, Family size, Perception of SWC and Social position, …
2.	HH Economics	farm size (area of cultivated, grass, land), ratio of total land to labor , Livestock holding, Off-farm income
3.	Institutional	Visits by DA (extension service), Technical support, Training, Security of land and Market distance, . . .
4.	Biophysical	Slope, Level of soil fertility, Type of soil erosion, Distance of each plot from home

CHAPTER THREE

3. RESULTS AND DISCUSSION

3.1. Descriptive Analysis

This chapter presents the survey data and interpretation of the analytical findings. Of the 100 sample respondents all reported that they have participated in the adoption of some soil and water conservation activities. However, the degree of adoption differs widely between households.

3.1.1 Demographic Characteristics

Household size and characteristics are directly related to the supply and demand conditions for basic human needs, such as food, shelter, health and educational facilities which in turn directly or indirectly influence the adoption of improved SWC technologies for a farming system. From the sample of 100 HH, the result indicates that 79% of the heads of household are male. These household heads include a wide range of people: village elders, decision makers (local administration), younger people, older people, poor farmers and rich farmers (Table 2).

Table 2: Characteristics of farm plots, related households and their heads

Description	No of observations	Min.	Max.	Mean	Std. Deviation
Education of HH head (years)	100	0	8	0.62	1.4
Age of HH head (years)	100	25	78	41.1	11.0
Family size	100	3	12	6.5	2.1
Area per plot (ha)	282	0	2	0.67	0.43
Distance of plot from home (walking minutes)	282	0	120	23.9	29.3
Distance of home to market (minutes)	100	10	300	86.9	58.3
Livestock holding in TLU	100	0	18.8	3.2	2.8

During the planning of SWC, it is important to consider the influential groups, but care still needs to be taken so that other groups are not marginalized.

Out of the total sample households in the study area, 21% of the household heads are women, who are single, widowed or divorced. No female household heads had almost adopted SWC practices. During discussions with women headed households the main reasons why women headed households are not involved in the adoption of SWC practices are that female heads have limited access to the information and that other socio-economic issues related to traditional social barriers limit women's resources. Women are also more involved in regular household activities than men. In the area, a woman takes most of the household responsibilities (child care, food processing and harvesting, weeding and bringing water from long distance). Most physical structures in the area require a great deal of labor for construction which cannot be undertaken by women alone. During informal discussions with key informants including women, most of the new SWC structural measures that were constructed in the past two years under the PSNP were not maintained.

The average age of the sample household heads is 41years with a standard deviation of 11 years. The average family size of the sample households is 6.5 persons with a standard deviation of 2.5. The family size of the sample households ranges from 3 to 12 persons (Table 2).

3.1.2 Education Status of Household

Three educational levels for household heads and seven education levels for family member groups were identified, which include: "illiterate" (meaning no formal education), "grade 1 - 4" and "grade $\geq$ 5" for household head and "illiterate", "grade 1

- 4”, “grade 5 - 8”, “grade 9 - 12”, “diploma (grade 10+3 or 12+2)”, “BSc degree” and ”degree above BSc” for family members. From the survey result, about 80% of the household heads had no formal education, 18% have completed up to a grade from 1 to 4 and 2% have completed grade 5 or higher (Table 3). In addition, about 53% of household family members had no formal education, 29% were educated to a grade between 1 and 4, 15% have reached a grade between 5 and 8, 2.6% reached a high school grade 9 or 10 (or 12 in some schools), 0.4% attained their high school diploma, and 0.2% completed a 4-year college degree. (Note that the 53% with no formal education includes infants and other young children.) However, none of the family members have gone above the 4-year degree level (Table 4). Most of the farmer household heads in the area are not educated and thus have little access to information about newly introduced soil and water conservation practice.

Table 3: Educational status of household heads

Description	Education level						Total HH heads
	Illiterate		grade 1-5		Above grade 5		
	No	%	No	%	No	%	
Overall HH head	80	80	18	18	2	2	100

Table 4: Education status of family members (not counting head of household)

Education level	**Number**	**Percentage**
Illiterate	289	53.2
Grade 1 -4	156	28.7
Grade 5 - 8	81	14.9
Grade 9 - 10/12	14	2.7
10+2 or 10+3 or 12+2 Diploma	2	0.4
BSc Degree	1	0.18
Above degree	0	0
Total number of family members	543	100

From the survey results, better-educated households have more realistic perceptions about soil erosion problems and more knowledge related to SWC and hence can more easily be involved in conservation activities. From discussion with key informants, with respect to educational status of households in relation to their location within the watershed, downstream farmers are better educated than upstream farmers of the Koga watershed because the downstream area is close to the Woreda town, *Merawi*, where more schools are available.

3.1.3 Age Status of Households

Three age groups for head of household are identified: 58% are between 20-40 years, 38% are between 40-64 years, and 4% are over 64 years. Most of the HH heads (96%) are in the age from 20-64 years group (Table 5). 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 4%, an age group in which labor shortage can be a hindrance to practicing soil and water conservation measures. 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 5: Age distribution of household heads

Description	Age range (years)						Total investigated
	20 - 40		40 - 64		> 64		
	Number	%	Number	%	Number	%	
Number of household heads in age group	58	58	38	38	4	4	100

Three age groups of family members were identified: 64% were less than 15 years old, 34% were between 15 and 64 years, and 2% older than 64 years (Table 6). In most Ethiopian rural areas, the main sources of labor are the family members, including wife and children. The sample households are characterized by a high proportion of young population (0-15 years) and a low number of old-age persons (> 64 years). Generally, there are more young people than older people; because of poor health care people die at a relatively young age.

Table 6: Age distribution of household family members (not counting head of household)

Description	Age range (years)						Total No HH members
	≤ 15		15 - 64		> 64		
	Number	%	Number	%	Number	%	
Over all	350	64	184	34	9	2	543

3.1.4 Off-Farm Economic Activities

In general, the relationship between off-farm employment and adoption performance of soil and water conservation is poorly understood (Kessler, 2006). Off-farm activities may have a negative effect on the adoption behavior of SWC due to reduced labor availability. When the farmer and family members are more involved in off-farm activities, the time spent on their farmland will be limited and hence the family is discouraged from being involved in construction and maintenance of SWC structures. On the other hand, off-farm activities can be a source of income and might encourage investment in farming and SWC.

The survey showed that 56% of the farmers are involved in various forms of off-farm activities. The major off-farm activity was collecting and selling of firewood. Other activities were petty trade, pottery, weaving, leather making, labor hired out and rental of a local “Gary” for transportation.

3.1.5 Perception and Attitude of Farmers

Perception of soil erosion as a hazard to agricultural production and sustainable agriculture is the most important determinant of effort at adoption of conservation measures. Theoretically, those farmers who perceive soil erosion as a problem having negative impacts on productivity and who expect positive returns from conservation are likely to decide in favor of adopting available conservation technologies (Semgalawe and Folmer, 2000; Gebremedhin and Swinton, 2003). On the other hand, when farmers do not acknowledge soil erosion as a problem, they will not expect benefits from controlling erosion and it is highly likely that they will decide against adopting any conservation technologies.

Thirty six percent of the sample farmers believed that overgrazing was the most important cause of soil erosion followed by 24% of the farmers who considered that deforestation caused the most erosion. Interestingly, only 12% found that cultivation of steeply sloping land was the most important cause (Table 7). This finding is consistent with findings in the Debre Mewi watershed by fellow student Tigist (2009), in which gully erosion in the overgrazed area was the source of most of the soil loss. Tigist found that gully development started when the watershed was being deforested. Thus findings in both areas stand in contrast to the common belief by outsiders that steep lands are the main cause of erosion.

Table 7: The perceived major causes of soil erosion and their ranks

	Ranks and percentage of responses (n=100)							
Causes of soil degradation	1st	2nd	3rd	4th	5th	6th	7th	8th
Deforestation	22	3	26	9	14	8	18	0
Over grazing	36	4	10	44	3	2	1	0
Over cultivation	1	44	11	15	9	11	6	3
Poor agricultural Practices	8	13	23	23	22	11	0	0
Cultivation of steep slopes	12	20	18	7	9	32	2	0
Excess rain fall	11	16	12	2	38	8	13	0
Poor government policies	7	0	0	0	5	28	33	27
Others	3	0	0	0	0	0	27	70

Table 8 presents farmers' awareness and perception of the erosion problem in the Koga watershed. All of the surveyed farmers (100%) acknowledged that soil erosion was a problem in their farm. Almost two thirds of the farmers observed that erosion had increased over the past 5 years. The opinion of the farmers on the impact of soil erosion on farm production was almost evenly divided between severe and moderate.

Comparing the number of respondents who rated the impact of soil erosion on farm production as 'smaller' to the number of respondents who rated the intensity of erosion as 'severe', it can be stated that the link between soil erosion and decline in land productivity may possibly be ambiguous to the farmers (Table 8). Additional evidence to this assumption is the explanation given by the farmers during informal discussions about decline in fertility levels of their lands. They generally agreed that there had been a decreasing trend in fertility levels of their plots of land, but that was attributed to immature of the land due to overuse, and erosion was rarely mentioned. In general terms, it can be concluded that the farmers were well aware of the problem of soil erosion.

Table 8: Farmers' perceptions of soil erosion hazards in the Koga watershed

Perception on erosion	Proportion of total Respondents (%)
Whether soil erosion was perceived as a problem in own farm	
- Yes	100.0%
- No	0.0%
Severity of the problem, if yes to the above question	
- Severe	35.8%
- Medium	62.8%
- Smaller	1.4%
Observed change in soil erosion severity over the past 5 years	
- Has become more severe	65.2%
- Has become less severe	34.1%
- No change	0.7%
Extent of impact of soil erosion on farm production	
- Severe	45.2%
- Moderate	52.9%
- Has no effect	1.9%
Believing that soil erosion can be controlled	
- Yes	70.0%
- No	30.0%

Also, the farmers generally believed that erosion can be controlled (70% of respondents). Hence, their lack of interest to adopt the introduced SWC measures cannot be explained by a lack of awareness about the problem and the potential for solving it. A similar result was reported by Bewket (2001), that the majority of the farmers had indicated soil erosion as an important agricultural problem, yet the majority again was not willingly participating in the construction of different bunds. In his study in southern Ethiopia, Tegene (1992) also reported that the majority of farmers were well aware of the problem of soil erosion, but they were less willing to utilize the introduced technologies. The implication is that correct perception of the erosion problem may be a necessary but not sufficient condition for farm-level adoption of SWC technologies.

3.1.6 Livestock Production

The type and total number of livestock owned across all sample households is given in Table 9. Sample farmers rear livestock for various purposes, including draught power, milk, meat, eggs, transport and other purposes. The main sources of feed for livestock in the study area include straw, grazing land and hola (maize stalk during its vegetative stage).

Table 9: Type and number of livestock owned by the sample households

Types of Livestock	No. of animals
Oxen	127
Cows	100
Calves	133
Heifer	4
Horses	6
Mules	7
Donkeys	6
Goats	47
Sheep	193
Chicken	243

Out of the total respondents, 24% do not have an ox and the others have one or more oxen. Most farmers reported that there is a shortage of feed for their animals, especially during the dry season.

3.2 Farmland Characteristics

3.2.1 Land Size and Distribution

Land in the study area is scarce mainly due to population pressure. The farm size varies between 0.25 and 3.75 ha (Table 10). The majority of farmers' land size was from 1 to 2 ha (Table 10). Average land holding for the sample households is 1.8 ha in upstream area and 1.9 ha in the downstream area. Because of the small farm size, fallow lands are not common and there is also a shortage of grazing land. Limiting fallow land loses an opportunity to increase soil fertility and reduce soil loss from erosion.

Table 10: Distribution of sample household heads by land holding

Farm size (ha)	Number of farmers	%
Up to 1	12	12
1 to 2	51	51
2 to 3	36	36
3 to 4	1	1
>4	0	0

3.2.2. Slope, Fertility, Soil Color and Degree of Erosion

Interviewers together with respondents classified each farm plot into flat (<6%), gentle slope (6-15%) and steep/mountainous (>15%), which require different types of soil conservation measures to reduce soil erosion. The physical characteristics of farm plots are indicated in Table 11. Of the total plots, only 12.8% are flat. This implies that according to soil and water conservation experts about 87% of the farm plots require conservation of one kind or another, in addition to volunteer flat land conservation practices. Respondents have also classified their own plot fertility into three categories: low, medium and high. A total of 282 farm plots divide into 17%, 68% and 15 % low, medium and high fertility respectively (Table 11). The farmers identified general soil colors: 87 % black, and 12 % sandy. Farmers usually consider black color soils as fertile in the study area. This may affect farmers' decisions on conservation because they want to take better care of fields that give better yield.

Only 15% of the plots were severely eroded. Most of the remaining plots were affected to some degree (Table 11).

Table 11: Distribution of farm plots by slope category, level of fertility, soil color and degree of erosion

		Number of plots	
	Description	**Frequency**	**%**
Slope category	Flat (< 6%)	36	12.8
	Gentle (6 - 15%)	200	70.9
	Steep/mountainous (>15%)	46	16.3
Fertility	Low	48	17
	Medium	191	67.7
	High	43	15.3
Soil color	Red	0	0
	Black	246	87.2
	Brown	0	0
	Sandy	33	11.8
Degree of erosion	Low	7	2.4
	Medium	234	83
	High	41	14.6

3.2.3 Distance between home and farmland

It has been found that distance between the farmland and a homestead is an important factor in the adoption behavior of soil and water conservation. In the study area the average walking time from the homestead to the farm land is 24 minutes. The scattered and far away fields are one of the factors that discourage farmers from adopting SWC measures. Shiferaw and Holden (1998) found that some farmers undertake SWC work during the evening, making it difficult to go to the fields that are located far from the home.

Regarding ownership and sources of farmland, the survey result showed that more than 85.9% of the plots are inherited from family. Almost 10% of the fields were distributed by village (kebele) leaders and nearly 5% of the fields were either rented or newly purchased by the current farmer (Table 12).

Table 12: Characteristics of farm land

Sources of land	Inherited		From kebele		Rented or bought by self		Other Sources	
	No	%	No	%	No	%	No	%
All plots used by sample households	242	85.9	27	9.5	13	4.6	0	0

3.2.4 Types of major crops

The major, stable cultivated crops are maize (44% of the plots) followed by dagusa and teff (22% and 20% of the plots respectively) (Table 13).

Table 13: Major types of crops in the study area

Major types of crops	Number of plots	
	Frequency	%
Maize/sorghum	125	44
Dagusa	62	22
Teff	57	20
Others	38	14

3.3 Soil and water conservation practices in the area

Various major soil and water conservation practices (*traditional* and improved) have been identified by the local development agent in the study area within the previous two years. Before the intervention through the Productive Safety Net Program (PSNP), farmers in the area were exclusively practicing traditional methods. Thus, the use of "improved" soil and water conservation measures is a recent development. Collaborating partners in PSNP included the agricultural office from Mecha Woreda, Koga Irrigation and Watershed Management project and farmers.

3.3.1 Traditional and newly introduced SWC practices

Until recently, traditional[2] soil and water conservation practices have often been ignored or underestimated by development agents, researchers, soil and water conservationists and government staff (IFAD, 1992). However, surveying both traditional and improved soil and water conservation practices provides an understanding of farmers' way of thinking about the interventions (Hudson, 1992). To prevent land degradation, especially soil erosion, in the Koga watershed, farmers use a number of traditional and improved soil and water conservation technologies. These technologies include application of manure, traditional and newly introduced cut-off drains, plantation of both traditional and newly introduced trees, stone bunds, leaving crop residues in the field and fallowing on the farm.

3.3.1.1 Cut-off drains

The survey results show that almost two thirds of the 282 sampled plots had traditional or improved cut-off drains (or both)[3] (Table 14). The farmers construct these drains to prevent loss of seeds, fertilizers, manure and soil due to water flowing onto the plot from uphill. The excess water is disposed away from the field**.** However, according to farmer opinions, some of the traditional drain structures enhance soil erosion through time. Transect walks with the key informants confirmed this, revealing several gullies between farm boundaries that were started by the cutoff drains. Farmers in the study

[2] The traditional soil and water conservation methods refer to practices built upon farmers' indigenous knowledge and experience. They include intensive cultivation, zero-grazing, agro-forestry, forestry (woodlot), furrow irrigation, trash lines, grass strips, minimum tillage, and biological or agronomic methods such as cereal-legume intercropping, rotation and mulching, residues of crop production.

[3] Cut off drains are both traditional and newly introduced SWC, one of the physical structures commonly constructed by digging a trench in order to divert the run off before reaching the farmland.

area are, therefore, reluctant to install this type of SWC practice. SWC technicians believe that by better surveying, the performance of the cutoff drains can be improved.

Table 14: Traditional and newly introduced SWC measures implemented by HH

	Description of SWC practices in the area	Traditional SWC practices	Newly introduced SWC practices	Koga Watershed	
				Number of plots	Percentage of total land
1.	Application of manure		▲	189	67%
2.	Traditional Cut-off drain	▲		184	65%
3.	Improved cut-off drain		▲	183	65%
4.	Plantation of both improved and traditional different trees	▲	▲	185	66%
5.	Soil/Stone bund terraces	▲	▲	173	61%
6.	Leaving crop residues on the field	▲		212	75%
7.	Contour farming	▲		126	45%
8.	Fallowing	▲		23	8%
9.	Fanya juu terraces		▲	0	0%

In studies in East Wellega Zone in Ethiopia, Azene (1997) showed that cut-off-drains (locally called “Boraatii”) constructed by farmers with oxen drawn ploughs, and reinforced with stones, wood blocks and grassed soil did not result in serious erosion.

3.3.1.2 Leaving crop residues

Another traditional practice common in the area is leaving crop residues on the field after harvest. There are two types of agricultural crop residues: process residues[4] and field residues[5]. Area farmers are generally not attempting to use crop residues to improve the fertility of soil. The survey results showed that most of the users are implementing this measure in order to protect the soil from erosion (Table 14). During the transect walks with the farmers, there were only small amounts of crop residues visible in farm plots. Key informants indicated that the farmers had serious fuel wood and animal feed shortages and therefore gradually used the crop residue for off-plot purposes.

Most of the farm households in the area, especially women members, collect crop residues from the field for animal feed and fuel wood. Similarly, research conducted by Tilahun (1996) found that farmers in Areka removed all crop residues from their fields and used them in their livestock pen or home garden. Some of the residues from cereals (wheat, barely and teff) and legumes (haricot beans and pea beans) are stored in the home compound and sold as fodder or used to feed livestock during the dry season.

3.3.1.3 Contour farming

Contour farming is a practice of cultivating the land along contours of equal elevation in order to reduce the runoff on lands with a slope over 6%. It is used alone or in

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[4] Process residues are those materials left after the processing of the crop into a usable resource. These residues include husks, seeds and roots. Crop residues can be used as animal fodder and soil amendment, and in manufacturing.

[5] Field residues are materials left in an agricultural field or orchard after the crop has been harvested. These residues include stalks and stubble (stems), leaves and seed pods. Good management of field residues can increase efficiency of irrigation and control of erosion.

combination with other conservation practices such as cut-off drains and plantation of different trees. (As indicated in Table 14, these two other practices are each used on two thirds of the surveyed plots.) Of the sampled plots, 45% had contour farming (Table 14) and although the farmer was aware of the soil and water conservation function of contour farming. In addition to this, it was implemented during land preparation before planting season because their ploughs the land for preparing an appropriate seedbed for production.

3.3.1.4 Fallowing

Fallowing[6] is one of the best methods to reduce soil fertility loss (Hudson, 1992). In the study area, fallowing is restricted to highly degraded lands which cannot be restored within a short period of time. In most cases only stones are found on these lands. Only 8% of the surveyed plots were fallowed (Table 14). During discussions with the farmers it was learned that through time, the traditional fallowing periods are practiced less and less as a result of the increasing population pressure and decreasing agricultural productivity.

3.3.1.5 Application of manure

Application of manure was used on more plots than any other conservation practice, 67% of the total (Table 14). Farmers applied manure near the homestead, rather than to land at a distance.

[6] Fallowing is a traditional practice of leaving the land out of production for 3-5 years for the purpose of restoring soil fertility and minimizing soil loss.

Based on focus group discussions with key informants, farmers have increased the amount of manure applied because of the high price of inorganic fertilizers (such as DAP and UREA) which the farmers cannot afford.

3.3.1.6 Plantations

Trees and other non-crop plants are planted on 66% of the surveyed plots sometimes together with other conservation practices (Table 14). During the transect walks, trees and other plants such as sisal were observed to be planted along the contour in order to reduce runoff and conserve the soil and water around the root of the plants (Figure 2). In general these plants are drought tolerant, not edible and therefore not destroyed by animals in the area. Another advantage is that farmers use these to mark the border between adjacent fields.

Figure 2: Plantation of Sisal and Euphorbia

3.3.1.7 Soil/stone bund terraces

About 61% of the surveyed plots included soil and stone bunds (Table 14). In the common land especially around the mountainous area, farmers were constructing bunds because of the cash they would earn from a safety net program. During focus group discussions with key informants, it was learned that farmers are well aware of erosion problem in the area. Moreover, they agree that bund terraces are effective in protecting the soil. The newly introduced SWC measures, stone and soil bunds, were widely acknowledged as being effective measures in arresting soil erosion and as having the potential to improve land productivity. Nevertheless, due to the top-down approach (haven't participation of Development Agents with local farmers), adoption of these new soil and water conservation practices by the farmers appears less likely (Mitiku H, Karl H., Brigitta S., 2006).

During discussions with key informants in each of the study areas, the farmers mentioned that ineffective designs by the development agents are responsible for causing gullies. Farmers use mostly soil/stone bunds that are impermeable intended to maintain all rainfall but when overtopped at one location will cause gullies unless they have specially designed spillways and protected soils below. These structures are better suited for semi-arid and arid parts of the country than in the high rainfall areas. This is in line with a study conducted by Belay (1992) in southern Ethiopia which concluded that farmers are willing to conserve their soil and water but demand more appropriate technologies, and that poorly designed practices can be the major cause of erosion in areas treated with SWC.

No surveyed plots had fanya juu[7] terraces (Table 14). Key informants indicated that the farmers were not aware of this SWC practice. Other farmers using this type of structure explained that the advantage of 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.

Figure 3: Fields with stone bunds are common in cultivated fields along transect in the Koga watershed, 2008.

[7] Fanya juu terraces are made by digging a trench and throwing the soil uphill to form an embankment, this after some years develops in to outward sloping bench terraces.

3.4 Econometric Analysis

The major objective of this section is to identify the relative importance of personal, socio economic, institutional and biophysical variables which affect smallholder farmers' decisions to adopt improved and traditional soil and water conservation structures. These variables were selected based on literature review.

There are different factors related to the adoption of soil and water conservation measures. Farmers seldom sustain the technical solutions offered by external interventions in the long term unless proper consideration is given to these factors (McDonald and Brown, 2000).

Previously, studies concerning adoption have identified household variables, farming and socio-economic variables and other external factors as the major determinants of adoption (Amsalu and De Graaff, 2007). In the Ethiopian case, several household and socio-economic factors that influence the decision to accept SWC measures have been identified. Amsalu and De Graaff (2006) found in the Beressa watershed in the Highlands of Ethiopia that age of the head of household, farm size, and numbers of livestock were factors that significantly influenced the adoption of SWC practices.

Before doing the analysis, it was necessary to check for the existence of multi-collinearity among the continuous variables and verify the degree of association among discrete variables. Correlation analysis showed that only two candidate variables suffered from significant multi-collinearity among the set of continuous and discrete predictor variables chosen for regression analysis at 5% confidence interval. The analysis omitted Extension contact and security of land tenure because of collinearity.

Table 15: Definition and measurement of variables used in the model

Variables	Description and unit of measurement
Dependent variables	
Y_1=ISOB	Improved soil/stone bund constructed (m/ha)
Y_2=ICOFD	Improved cut-off drain (check dam) constructed (m/ha)
Y_3=PLTRE	Covered Plantation of trees (no/ha)
Explanatory variables	
X_1=AGEHH	Age of the household head (years)
X_2=EDUHH	Education of head of household (years)
X_3=SEXHH	Sex of household: 1 if the household is male, 0 otherwise
X_4=TOFAM	Family size of the household (numbers)
X_5=PERCP	Perception of the household head about soil erosion problem: 1 if the household head perceive soil erosion problem in his farm, 0 otherwise
X_6= SOCIAL	Social position of the household head: 1 if the household head has social position in the kebele, 0 otherwise
X_7 =ATLND	Area of total farmland (ha)
X_8=LNDLBR	Ratio of total land to labor (hectare per man days)
X_9=TLS	Livestock holding of the household (numbers)
X_{10}=OFINCOM	Off-farm income (ETB)
X_{11}= ACTRA	Access to training about SWC practices (numbers)
X_{12}=DIMAR	Walking distance to the market (minutes)
X_{13}=SLOP	Slope category of a plot: 1 flat; 2 steep land; 0 other wise
X_{14}=DISTP	Walking distance to the farm plot from home (minutes)
X_{15}=EXT	Extension contact: 1 if the farmer gets extension contact, 0 Otherwise
X_{16}=LNDSECU	Security of land tenure: 1 if the farmer considered that he/she will be able to use the plot at least during his /her lifetime, 0 other wise

3.4.1. Factors affecting adoption of SWC practices

Tobit model analysis has been used to examine the determinants of adoption of selected soil and water conservation practices in Koga watershed. Lengths of constructed improved and traditional soil and water conservation structures in meters per hectare, and numbers of trees per hectare, were chosen as three proxy measures of conservation efforts. Results of the Tobit regression analysis are presented in Table 16.

Among the many hypothesized explanatory variables, only seven variables were found to significantly affect improved soil and stone bund terraces. Five variables significantly affected improved cut-off drains and two variables significantly affected the adoption of tree plantations. The log likelihood ratios for all cases were significant at the $p < 0.05$ probability level. This indicates that there exists useful information in the estimated Tobit model.

The results indicate that the significant (at 5%) variables affecting adoption of at least one of three improved SWC (Soil/stone bund terraces, cut-off drains and plantation of trees) efforts in the study area include area of total farm land (ATLND), land to labor ratio (LNDLBR), age of the household head (AGEHH), education level of the household head (EDUHH), distance of the farm plot from home (DIPLO), slope of the farm plots (SLOP), total family size (TOFAM), total livestock holding capacity (TOLS), access to training (ACTRA) and distance of the market from home (DIMAR). Variables sex of HH head (SEXHH), perception of an erosion problem (PERCP), social position of HH head (SOCIAL), and off-farm income (OFINCO) did not have coefficients significantly different from zero in any of the three equations.

Table 16: Maximum likelihood estimates of Tobit Model results (adoption of improved soil and water conservation practices)

	DEPENDENT VARIABLES											
	Y_1 (soil/stone bund terrace)				Y2 (cut-off drain)				Y3 (tree plantation)			
Parameters	Bi	SE	T-val.	Change Prob.	Bi	SE	T-val.	Change Prob.	Bi	SE	T-val.	Change Prob.
X1=AGEHH	0.425	0.26	1.62	0.105	0.352	0.14	2.44	0.016	0.470	0.97	0.48	0.629
X2=EDUHH	3.823	1.96	1.95	0.003	0.114	1.09	0.1	0.917	5.932	7.13	0.83	0.406
X3=SEXHH	-3.883	6.73	-0.58	0.565	-4.389	3.71	-1.18	0.238	22.431	24.6	-0.91	0.363
X4=TOFAM	-3.383	1.15	-2.93	0.003	-1.687	0.63	-2.66	0.008	11.342	4.26	-2.66	0.008
X5=PERCP	51.362	28.9	1.78	0.076	18.212	16	1.14	0.256	31.803	106	-0.3	0.765
X6=SOCIAL	-0.840	1.91	-0.44	0.660	-1.702	1.05	-1.62	0.105	-3.346	6.94	-0.48	0.630
X7=ATLAND	20.077	9.31	2.16	0.002	10.373	5.15	2.01	0.045	39.324	34.4	-1.14	0.253
X8=LNDLBR	-563.63	513	-1.1	0.273	513.98	287	-1.79	0.005	92.600	875	0.05	0.961
X9=TOLS	1.542	0.32	4.8	0.000	0.561	0.17	3.16	0.002	3.083	1.16	2.65	0.001
X10=OFINCO	0.016	0.01	1.71	0.089	0.004	0	0.84	0.402	-0.040	0.03	-1.12	0.263
X11=ACTRA	-6.173	6.24	-0.99	0.323	-8.474	3.39	-2.5	0.013	22.776	22.5	-1.01	0.312
X12=DIMAR	0.113	0.05	2.36	0.019	0.030	0.02	1.15	0.253	0.235	0.17	1.35	Error
X13=SLOP	16.061	6.83	2.35	0.009	5.188	3.69	1.4	0.161	-0.300	0.23	-1.3	Error
X14=DIPLO	-0.311	0.07	-4.65	0.000	-0.209	0.04	-5.67	0.000	195.00	134	1.46	Error

Where, Bi represents the regression coefficient associated with the variable
SE means standard error of the regression coefficient
T-val. is Bi/SE
Change prob. is the probability that Bi is not significantly different from zero

Table 17 presents the actual and expected coefficient signs based on Table 16, also indicating which coefficients are not significantly different from zero. The signs (+ or direct/- or inverse relationship between the dependent and independent variables) of the estimated coefficients with significances at 5% or better are consistent with prior sign expectations except for access to training (negative instead of positive, for cut-off drains) and walking distance to market (positive instead of negative, for bunds) (Table 17).

Table 17: Estimated sign of the different variable

Description	**Expected sign**	**Sign for bunds (Y1)**	**Sign for cut-off drains (Y2)**	**Sign for tree plantation (Y3)**
Age of the household head	+	(+)	+	(+)
Education of head of household	+	+	(+)	(+)
Sex of household	+	(-)	(-)	(-)
Family size of the household	-	-	-	-
Perception of the household head about soil erosion problem	+	(+)	(+)	(-)
Social position of the household head	+	(-)	(-)	(-)
Area of total farmland	+	+	+	(-)
Ratio of total land to labor	-	(-)	-	(+)
Livestock holding of the household	+	+	+	+
Off-farm income	+	(+)	(+)	(-)
Access to training about SWC practices	+	(-)	-	(-)
Walking distance to the market	-	+	(+)	(+)
Slope category of a plot	+	+	(+)	(-)
Walking distance to the farm plot from home	-	-	-	(-)

Sign in parentheses () indicates that coefficient was not significantly different from 0 at the 0.05 level.

3.4.1.1 Personal factors in relation to adoption of SWC

The personal factors that are considered in relation to adoption behavior of SWC included age, education and family size. The influence of farmers' age[8] on the adoption performance of soil and water conservation is positive and it is statistically significant with cut-off drain types of SWC. A unit increase in age of HH head increases the adoption behavior of improved cut-off drains by 0.35% (Table 16). The positive sign indicates that, as a farmer's age increases, the adoption behavior of improved cut-off drains increases. The hypothesis that younger farmers do not expend more effort on improved soil and water conservation measures, especially improved cut-off drains compared to older ones, was motivated by the view that older farmers have experience . Therefore, they were more aware of the problems of erosion and the importance of soil and water conservation practices. Another reason for the expected positive relationship between age of HH head and conservation effort is that older farmers have sufficient land for adopting improved SWC structures while younger farmers do not.

There is significant correlation between the education[9] level of household head and the adoption of soil/stone bund terraces (Table 16). Education increased the adoption behavior of improved soil/stone bund terraces by 3.8% per additional year of education. This provides support for the hypothesis that better education levels are

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[8] Age of the household head: This is a continuous independent variable indicating the farming experience of the household head in years. Through experience, farmers may perceive and analyze the problem of soil erosion and to develop confidence to use soil-conserving measures. Thus, more experienced farmers in farming are more likely to use soil conserving technologies than less experienced farmers.

[9] Education: Refers to the number of years of formal education completed by the head of the household. Educated farmers can understand, analyze, and interpret the advantage of different technologies more easily than uneducated farmers. Therefore, farmers who have greater year of schooling are expected more likely to use soil and water-conserving technologies.

associated with greater information on conservation measures and in turn results in a greater adoption of soil and water conservation practices. Krishana *et.al.* (2008) found that education of the HH head was positively related to the adoption of improved SWC technology. Therefore, if the amount of educated people increases, the country sustainable development will be improved.

The family size of households has an impact on the investment in all three types of soil and water conservation practices. As mentioned above, population growth has brought about land scarcity and land degradation in the study area. Table 16 is consistent with this because survey results show that a one-person increase in family size decreases the adoption of soil/stone bund terraces by 3.4%, cut-off drains by 1.7% and tree plantation by 11.3%. It is plausible that large families do not spend their money on conservation practices; rather they spend it for food and other basic necessities.

Similarly Amsalu (2006) found that, in the Beressa watershed in the highlands of Ethiopia, larger families were less likely to continue using stone terraces. Bekele and Drake (2003) also found similar results in the eastern highlands of the Ethiopia. They noted that in a family with a large number of mouths to feed, there was competition for labor between off-farm activities to earn cash for buying food and maintenance of SWC. Moreover as population increases, landholding per household gradually decreases which in turn has a negative impact on soil and water conservation.

It was surprising that the SEXHH variable did not have a significant relationship to any of the three SWC practice proxies, because of the existing strengthen capacity of women farmers for work in the study area.

3.4.1.2 Socio-economic factors in relation to adoption of SWC

The main and significant economic factors considered in this study are the area of farmland, land to labor ratio and livestock holding of the household. Economic factors can play important role in determining the adoption of SWC practices.

Among the economic factors, farm size[10] is an important variable in relation to the adoption of soil and water conservation (Table 16). Areas of farmland had positive and significant influence on the adoption of improved soil/stone bund terraces and cut-off drains, but not on tree plantation. From the survey result, for a 1 hectare increase in farmland, the probability of adoption of bunds increases by 20% (Table 16). Large farms have land available for soil/stone bund while on small farmers all land is needed for crop production.

Amsalu and Graaff (2007) similarly found that farmers who have a larger farm are more likely to invest in soil conservation measures because they have the funds to do so.

Land to labor ratio[11] negatively affected the adoption of cut-off drain SWC. A unit increase in land to labor ratio decreased the adoption of cut-off drains by 51% (Table 16). Implementation of SWC structure is labor intensive and therefore implementation

[10] Area of farm land (farm size): Soil and water conservation structures may take some area that would have been used for farm (growing of crops). Farmers who operate on larger farms can allocate some part of the land than those who have small farms. Therefore, it is anticipated that farm size and the likelihood of using soil-and-water conserving technologies are positively correlated.

[11] Land to labor ratio measured as the ratio of the area operated to the number of family members engaged in farming is used as an indicator of the population pressure. Households with lower land to labor ratio may have incentives to invest in soil conservation. On the other hand, the potential loss of land to soil conserving structures may discourage use of soil and water conserving Structures. For households with more land per unit of labor, this potential loss of land and the subsequent reduction in cropping area may be less of a constraint relative to those with little land. Hence households with higher land to labor ratio may be more likely to use soil and water conservation structures. The effect of land to labor ratio is, therefore, indeterminate a priori.

is related more to labor availability than to land size. This finding lends support to the hypothesis that as population grows relative to land resources, land will be more intensively cultivated (Boserup, 1965).

Another important component of the farming system in the study area is livestock rearing. Most farmers reported that there was shortage of feed for their livestock, especially during the dry season. The average size of livestock holding in each HH measured in terms of tropical livestock unit (TLU) was found to be 3.2 (Appendix 1). Increased livestock holdings[12] are positively related to the adoption of improved soil/stone bund terraces, cut-off drain and tree plantation of SWC structures (at 5% significant level, Table 16). The survey result show that a unit increase in livestock increased the adoption of improved soil/stone bund terraces by 1.5%, cut-off drains by 0.6% and tree plantations by 3.1%. This may imply that money earned from the livestock makes possible the purchase of materials for construction of SWC structures.

3.4.1.3 Institutional factors in relation to adoption of SWC

For the purpose of this thesis the institutional factors consist of: visits by development agent (DA), technical support, training, land tenure and distance to market. Institutional factors did not affect significantly the rate of adoption of soil and water conservation practices with the exception of the distance between the market and

[12] Livestock holding: This variable represents the livestock holding of the household in tropical livestock unit. It is used as an indicator of wealth. More specialization into livestock away from cropping may reduce the economic impact of soil erosion and lower the need for soil conservation. On the other hand, those farmers who have large number of livestock may have more capital to invest in soil conservation practices. This affects the use of soil conservation measures positively. However, in the case of the study area, conservation technologies are more labor intensive and require less capital. Therefore, the size of livestock holding is hypothesized to affect conservation investment negatively.

household home. Interestingly the larger the distance to the market[13] the greater the adoption of soil/stone bund terraces and cut-off drains (Table 16). For each minute increase in walking to the market the soil/stone bund terraces increased by 0.11% and the number of cut-off drains increased by 0.03%.

Farmers cannot adopt technologies if they do not have access to all the relevant information, but the information they are given is often incomplete, focusing only on the technical aspects and overlooking some key criteria from a farmer's point of view. From the result, access to training had a significant negative effect on use of cut-off drains because the information they were get about cut-off training is often incomplete relative to other practices. So, most trained farmers adopt other practices rather than cut-off drain. Therefore, nor can they adopt technologies if they do not clearly perceive information that scope of returns could be expected after adoption.

It was not possible to test the effect of renting land on adoption of SWC practices due to the small number of farmers who rented land in the sample, According to Bakhsh, Kanwar and Ahuja. (1998), farmers are not likely to invest in rented property if it is unlikely that their investments can be recouped.

3.4.1.4 Biophysical factors in relation to adoption of SWC

Another group of characteristics that determines the adoption of SWC structures are the biophysical factors. They include the distance between the plot and the household

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[13] Distance of the market: It refers to the average distance of the market from residence home. Farmers whose markets were far to their residence use soil-and-water conserving technologies because the time and energy they spend to market is changed in to constructing SWC measurement in their field. Therefore, distance from residence more likely affects conservation practices positively.

and the slope of the plot (flat, steeper and very steeper). Longer walking distance[14] between plot and the household was significantly related to a reduced adoption of soil/stone bund terraces and cut-off drains. A one minute increase in walking time decreased length of soil/stone bund terrace by 0.31% and length of cut-off drain by 0.25%. Berhanu and Swinton (2003) in their study of investment in soil conservation in Northern Ethiopia like wise found that plots distant from homesteads discouraged investment in soil conservation.

Sloping land had significantly more soil/stone bund terraces than flat fields (Table 16). A unit increase in the ordinal slope (from flat to very steep slope), increases the probability of adopting bund terraces by 16.1%. This is similar to the findings of Amsalu (2006).

Plantations of trees were implemented mostly in flat lands in the study area (Figure 4) because flat lands were degraded mostly by overgrazing, over cultivation, deforestation and poor agricultural practices. Farmers were confident to adopt plantation of trees due to effectiveness of the measure to rehabilitate degraded land and control erosion on flat land.

[14] Distance of the farm: It refers to the average distance of the farm from residence. Farmers whose farms are nearer to their residence use soil-conserving technologies because the time and energy they spend is lesser for nearer farms than distant farms. Therefore, distance from residence more likely affects conservation practices negatively.


Figure 4: Planting of trees in flat land areas of Koga watershed

CHAPTER-FOUR

4. SUMMARY AND CONCLUSION

4.1 Summary

Agricultural development in Ethiopia is hampered by land degradation; degradation in turn is threatening the overall sustainability of agricultural production. Soil erosion is a major cause of land degradation in Ethiopia.

Based on the result of this study, personal factors, socio-economic factors and livestock holding capacity of HH, institutional factors, biophysical factors and degree of slope significantly affect the probability of adopting both improved and traditional soil and water conservation measures.

Farmers' age and education level of HH head have a positive impact on adoption of some soil and water conservation practices. Older farmers have advantages of more experience and access to more farmlands, and younger farmers possess a higher level of education. Degree of slope increased the use of bund terraces while distance of farm plots from home had negative influences on bunds and cut-off drains. The results are consistent with the woreda's hilly and rugged topography especially above the Irrigation Dam. The cost of soil and water conservation also includes the cost of travel to the plot from home. Land to labor ratio affects the adoption of cut-off drains.

4.2 Conclusion

Understanding of personal, socio-economic, institutional and biophysical factors would contribute to the design of appropriate strategies to achieve technical change in soil and water conservation process in the study area and other similar areas of the region and as well as the country.

On the basis of the survey results and literature reviewed, the following points were made.

- Soil and water conservation policies that fail to account for inter household and inter plot variation and important biophysical factors that influence the adoption of soil and water conservation measures by farmers are unlikely to be effective. Therefore, policies should consider differences in the above factors in the design and promotion of conservation technologies.

- Investment in physical soil and water conserving technologies becomes more attractive as the area of farm land is larger, i.e. farmers make more soil and water conservation investment in holdings that are wider in area.

- From the informal discussion, key informants said concerned organizations and government bodies involved in soil conservation should shift emphasis to give greater attention in conserving soils before the land lost all the fertile soils rather than targeting land that has been already exhausted and degraded.

As the results indicated, SWC structures are more likely to be implemented and maintained on low fertility and steep sloping farmland by giving the priority for it rather than fertile lands, because labor and other resources are scarce.

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APPENDICES

Appendix 1: Conversion factors used to estimate tropical livestock units (TLU)

Animals	TLU equivalent
Calf	0.25
Heifer	0.75
Cows and Oxen	1.00
Horse	1.10
Donkey	0.70
Sheep and Goats	0.13
Chicken	0.013

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

Appendix 2: Conversion factors used to estimate labor equivalent (man days)

Age group	Gender	
(Years)	Male	Female
Below 10	0	0
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1.0	0.8
Over50	0.7	0.5

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

Appendix 3: Structural survey questionnaire for formal interviewer

Farmers survey on adoption of soil and water conservation practices in Koga Watershed, Ethiopia

Masters thesis Survey
Fikru Assefa
Cornell University

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)
4) Widow 99) No applicable
1.5) Kebele 1. Enamrit 2. Andinet 3. Kudimi 4. Rim 5. Kurt-Bahir 6. Midre-Genet
1.6) Strata 1. Up stream 2. Down stream
1.7) Distance to woreda market__________ (in minutes)
1.8) Social position in the kebele
1) Member of kebele council 2) Religious leader
3) Others, specify_____________________ 4) none
1.9) Education 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),
Above________ (No)

3) Landholding and farm characteristics

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

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

No	Description	Plot 1	Plot 2	Plot 3	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=Horse bean 9=Field peas 10=Rice 11=Triticale 12=Noug 13=Onion14=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 25.					
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.	Color of the soil 1) red 2) black 3) brown 4) sandy 5) 2 & 4					
16.	Degree of erosion problem on the plot 1) high 2)medium 3)low					
17.	Number of years since the plot is used					
18.	Irrigated 1) yes 2) no					
19.	Presence of at least one type of improved Conservation structures 1) yes 2)no					
20.	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					
21.	Who constructed the structures? 1) Community participation 2) Family (hired) labor 3) Financial incentives by government 4) labor exchange 5)NA					
22.	Do improved soil and water conservation structures maintained or not 1)yes 2)no 3) NA					
23.	Who did the maintenance work? 1) Community participation 2) Family 3) hired labor 4) Labor exchange 5. NA					
24.	Status (degree) of use of improved soil conservation structures (practices) 1) Removed totally; 2) Partially removed 3) Not removed; 4) Modified (adapted) 5) NA					
25.	Traditional soil and water conservation structures built (in meter) 1.Traditional stone bund					

	2.Traditional ditches 3.Trash (garbage) lines 4. Cut off-drain 5. Plantation 6. Others, specify					
26.	Total LMDs for conservation per annually					
27.	Total LMDs for maintenance per annually					
28.	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					
29.	How do you compare the problem of soil erosion in your farm plots after conservation structures were built? 1) aggravated 2) reduced 3) no change 4) I do not know 5) NA					

5) Labor Availability

5.1) Do you have labor shortage for your farm activities? 1) Yes 2) No

5.2) If the answer to question 4.1 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

5.5) Which family members participate in soil and water conservation 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 2007/08

No	Types of off-farm (non- farm) activity		Total income obtained in one year (birr), approximate
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 #V068 is from 1-7, Which Family members working non-farm activity?
1) Men 2) Women 3) Children 4) All 5) NA

6) Perception of soil erosion problems

6.1) Do 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) __________________

6.3) what 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 (%)
Whether soil erosion was perceived as a problem in own farm	
Yes	
No	
Severity of the problem, if yes to the above question	
Severe	
Medium	
Moderate	
Observed change in soil erosion severity over the past 5 years	
Has become more severe	
Has become less severe	
No change	
Extent of impact of soil erosion on farm production	
Severe	
Moderate	
Has no effect	
Believing that soil erosion can be controlled	
Yes	
No	

7) Soil and water Conservation technologies 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) Fanya juu 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 soil and water conservation measurers are efficient to reduce the problem of soil erosion?
1) Stone bund 2) Soil bund
3) Cut off drain 4) Water way
5) Fanya 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) 1,2,6 13) 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 soil and water conservation 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 99) NA

7.10) what are the problems related to each soil and water conservation structures?
Hint, choose from 1-5

Problems	Soil bund	Cut off drain	Water way	Plantation
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 **3)** 1, 4, 6 **7)** 2, 4 **8)** 3, 4
9) 2, 4, 6 **10)** 2, 3 **11)** 2, 3, 4 **12)** 1, 3, 6 **13)** 1, 2, 6
14) 1,2,3,6 **15)** 4, 5, 6 1**6)** 2, 6 17**)** 1, 2, 3 18**)** 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 soil and water conservation for the last five years?
1) Yes 2) No
9.6) If yes, for how many days? ___________days 99) 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

10.1) Livestock

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	

10.2) what are the main source 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

Thank you very much for your cooperation!!!

GLOSSARY

Birr (ETB)	Ethiopian currency (One USD ≈ 9.96 Birr)
Kebele	A peasant association; it is also the lowest administrative unit in rural Ethiopia; it has an area of about approximate 800 ha.
Mareshsa	A traditional implement used for cultivation of the farm by oxen.
Teff	A main cereal staple grown and used in Ethiopia.
Woreda	An administrative unit somewhat equivalent to a district. A woreda consists of several peasant associations (PAs).
Zone	An administrative unit somewhat having different district. A Zone consists of several Woredas.