Determinants of the Use of Soil Conservation Technologies by Smallholder Farmers: The Case of Hulet Eju Enesie District, East Gojjam Zone, Ethiopia

Derajew Fentie[1], Bekabil Fufa[2], Wagayehu Bekele[3]

[1] Lecturur in Debremarkos Unversity, department of Rural developmwent
Debremarkos, Ethiopia

[2] Lecturur in Haramaya University, Departments of Agricultural Economics,
Haramaya University, Ethiopia

[3] president of Dire-dewa University, Ethiopia

**ABSTRACT—*This study is examined the socio- economic, institutional and technical factors that determine the use of improved soil conservation technologies in East Gojjam Zone, Hulet Eju Enesie district. To address the objective of the study both primary and secondary data were collected. The primary data were collected from 120 sample households who are selected from 4 Peasant Associations (PAs) in Hult Eju Enesie district proportionately and randomly of which 118 sample households possessing 382 farm plots were used for the analysis. Two-limit Tobit model was used to estimate factors that affect the use of improved soil conservation technologies. In addition descriptive statistics were also used as deemed necessary. The results of this study indicated that educational level of the household head; extension contact; and slope of the plot positively and significantly affect farmers' conservation decision and the extent of use of improved soil conservation technologies. Whereas, distance of the plot from residence, livestock holding and fertility of farm plot affect negatively and significantly farmers' conservation decision and the extent of use of improved soil conservation technologies. Thus, the important recommendations which are found to be of paramount importance from the findings of this study include: strategies which focus on enhancing the willingness and /or ability of farmers should be adopted, strengthen learning opportunities through facilitating the establishment of farmers training center and their operation in rural areas of the administration, strengthen the extension contact between farmers and development agents and the need to providing farmers with information on long term impact of soil erosion on the present fertile plots.*

Keywords— Improved soil conservation technologies; adoption; Two-limit Tobit model; *Hulet Eju Enesie district (Ethiopia)*

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1. INTRODUCTION

The productivity of agricultural economy, which is the back bone of the country economy, is being seriously eroded by unsustainable land management practices both in areas of food crops and in grazing lands **(**Leonard, 2003**).** Although other factors like shortage of rainfall and poor land management are the principal contributing factor to the low and declining agricultural productivity in Ethiopia, which is explained by the loss of soil fertility (FAO, 2000; Bayramin *et.al*, 2002). The resultant effect of land degradation can be detected by the decline of crop yields, decline of water and forest resources and by gully formation across the grazing and ploughing fields.

Environmental and natural resource degradation is a major concern in Ethiopia, because of its devastating consequences on economic growth and food security status of the people which are both highly dependent on natural resources (Girma, 2001). The problems of land degradation and low agricultural productivity, which results in food insecurity and poverty, are particularly severe in the rural highlands of Ethiopia that constitute 95% of the cultivable area in the country and that support 88% of the human and 75% of the livestock population (Holden *et al*., 2005). Land degradation is a great threat to the future agricultural productivity and it requires great effort to protect resources (Girma, 2001). The rapid population increment, severe soil loss, deforestation, low vegetative cover and unbalanced crop and livestock production are the major causes of land degradation in Ethiopia (Leonard, 2003; Lulseged and Paul, 2006).

Soil erosion in Ethiopia is not a new phenomenon. It is as old as the history of agriculture it self. However, the problem attracted policy attention only after the devastating famine problem in 1973/74 (Bekele and Holden, 1998). Prior to, 1974 the conservation of agricultural land was largely neglected due to the singular dominance of policy to favor industrial growth over that of agriculture (Bekele and Holden, 1999; Wagayehu, 2003). Moreover, the political and socio-economic systems, which characterize most of Ethiopia's past, resulted in the neglect of conservation of natural resources. The problem is only identified after the situation has already become serious usually by the time much of the topsoil has been lost and the productivity of the land seriously impaired (Ayalneh, 2002).

The average annual rate of soil loss in Ethiopia is estimated to be 12 tons/hectare/year, and it can be even higher on steep slopes with soil loss rates greater than 300 tons/hectare/year, where vegetation cover is scant (USAID, 2000). Sonneveld (2002) also estimated that the loss of agricultural value due to land degradation between 2000 and 2010 would be $US 7 billion; a huge sum in relation to current investments in sustainable land management. The poor soil management and land use practices are the causes of the high soil erosion rate (Nigussie and Fekadu, 2003).

To overcome the problem of land degradation on agricultural productivity, Ethiopia has made efforts to launch afforestation and conservation programs with the support of both government and non-government organizations; however, success to date has been limited (Bishaw, 2001). At present extent and speed of land degradation, particularly due to soil erosion is distinguished as a serious threat to the viability of the subsistence agriculture in the amhara regional state (Lakew *et al*., 2000). Income of farmer's is highly dependent on crop and livestock production with a limited off-farm income. However, its production and productivity is highly influenced by soil erosion. Its severity is explained by a decline in productivity, formation of small gullies in both farming and grazing lands through time. Given this state of conditions, analysis of the issue of what specifically determines the decision taken by farmers to invest in soil conservation technologies is very important and relevant to formulate policy options and support systems that could accelerate use of soil conservation technologies. Accordingly, this study was conducted in Hulet Eju Enesie district of East Gojjam zone of Amhara region with the objectivies (i) to identify the most commonly used improved soil conservation methods in the study area, (ii) to identify factors that affects the probability and intensity use of improved soil conservation technologies in the Study area.

1.1. Causes and Consequences of Land Degradation

Over the past 10 years the occurrence of agricultural and environmental crises in Sub Saharan Africa (SSA) has become increasing, soil erosion, soil fertility loss are considered to be undermining the productive capacity of agricultural systems. These problems have been ascribed to many different causes, including social, economic, institutional, biological and physical factors (Benine *et al*., 2002). Land degradation is believed to be the direct causes of population pressure, poverty, limited access to agricultural inputs, information and credits, low productivity of agricultural production practices, fragmented and insecure land holdings (Tesfaye, 2003; Pender *et al.*, 2004).

Many empirical studies have indicated that the main forms of land degradation such as deforestation, overgrazing, cultivation of marginal lands and soil fertility depletion can be attributing to population pressure (Harrison, 1987; FAO, 1990; Hurni, 1991; Hurni *et al*, 1997; Ritler, 1997; cited in Yohannes 1999). The FAO (1979) methodology, classify the causes of soil erosion, which is the main form of land degradation in developing countries in to physical and human factors. This source further explained that population growth and apparently decline in holdings (fragmentations) are the first most important perceived causes of human induced land degradation. As population increases many farming households are pushed to poor marginal agricultural lands where inadequate and unreliable rain fall, adverse soil condition, fertility and topography limit agricultural productivity and increase the risk of chronic land degradation.

Population pressure coupled with unfavorable land tenure system has been responsible for over ploughing and overgrazing of farm lands. Environmental degradation has resulted from mismanagement of land resource, overgrazing, deforestation and inappropriate land use systems. This is fully reflected in the massive soil erosion that has taken place with the consequence of serious destruction of the fertile top soils in many parts of the country. Inappropriate and destructive farming practices have, to some extent, been responsible for the recurrence of droughts in a large part of the country (Sonneveld and Keyzer, 2002).

Many authors stress the negative effects of land degradation on the livelihood of the farmer and the economic life of the wider community (e.g. FAO, 1997; Stocking, 1984/85; Mesfin W.mariam, 1984 and Blaikie, 1985, cited in Yohannes 1999). At level of the individual farmer the major negative effects of environmental degradation are reflected in falling incomes. Soil erosion tends to be associated with reductions in crop yields, fodder (pasture) and forest area. Moreover, general economic deterioration contributes to a vicious circle because the progressively impoverished farmers lack the economic means to tackle their environmental problems.

Degradation of soil resource in Ethiopia is seriously limiting production. In economic term; the productive capacity of the soils in the Ethiopian high lands is being greatly undermined. FAO (2000) estimated that some 50% of the highlands are significantly eroded, of which 25% are seriously eroded, and 4% have reached at a point of no return. The area of cropland that constitutes 13% of Ethiopia's land mass is the leading region of soil loss, with an average erosion of 42 ton ha^{-1}.

The joint effect of wide spread poverty, land degradation, population pressure, and institutional failures etc. in Ethiopia has in recent times begun to manifest it self in deteriorating food security even in years of good weather condition for agriculture. In this respect (Hurni, 1993) reported that in Ethiopia areas that suffer from frequent famines are also those exhibiting highest annual rates of soil erosion. Therefore, designing and formulating appropriate soil conservation strategies, considering the various socio-economic, political and cultural environments are urgently needed in order to attain sustainable economic development at a national level.

1.2. Empirical Studies on Soil Conservation Decisions

Agricultural production in Ethiopia is highly influenced by a decline in productivity due a decline in soil fertility. Soil erosion is a great threat to the nation's future food security and development prospective. On top of this, farm households' land use and conservation decisions are likely to be influenced by a number of factors. Due to this, numerous empirical technology adoption studies have been conducted for the last many years by different researchers with in and out of the country. The results of these studies, however, are inconsistent. In this section attempts will be made to illustrate the findings that have been drawn from these studies.

Lynne *et al*. (1988) on their study on attitudes and farmers conservation behavior stated that, factors such as income and nature of terrain were found to affect conservation behavior. Farmer's attitude influences the amount of effort exerted in conservation. The authors also suggested other factors including attitude towards investment risk, extension education and percentage of cultivated land affect conservation decision.

A study conducted by Laper and Pandy (1999) on adoption of soil conservation in Philippine uplands, using probit model showed that the high cost of establishment, maintenance and the loss of land to hedgerows are considered to be the major constraints to adoption by non adopters. The economies of the contour hedgerow system are found to improve substantially if crop intensification or cash cropping is possible. In the marginal environments on site benefits alone may not be sufficient to justify investment in soil conservation.

A study made on factors influencing adoption of land enhancing technology in the Sahel, Niger by Baidu-Ferson (1999), using Tobit model indicated that higher percentage of degraded farm land, extension education, lower risk aversion, and the availability of short term profits are important for increasing the adoption and intensity of use of improved technologies. However, age and attitudes to differentia l gains between farm and non-farm income showed no influence on adoption.

Araya and Adjaye (2001) used Tobit analysis to examine factors affecting use of soil conservation technologies in Eritrea using the total number of days spent on soil conservation as a proxy measure of soil conservation effort. The result indicated that among variables examined in this study family size, perceptions about the effect of soil conservation on yield, perception about the profitability of soil conservation measures, off farm employment and the system of land ownership significantly affect soil conservation effort of farmers in the study area.

A study conducted by Wagayehu (2003) on soil and water conservation decision behavior of subsistence farmers in the Eastern high lands of Ethiopia, using multinomial logit analysis showed that, plot area and slope, access to information, and project assistance have positive and significant influence on conservation decisions. Whereas, family size and the land holding per economically active persons in the family was found to have a negative influence on decision. This study suggest that in promoting SWC technologies to farmers, attention needs to be paid to the agro ecological variations of the farming environment and socio-economic characteristics of the target groups, and the need for designing and implementing appropriate policies and programs that will influence farmers' behavior towards the introduction of soil and water conservation measures in their agricultural practices.

A study conducted by Tesfaye (2003), On SWC use in Konso, Wolita and Wello, Ethiopia; indicated that land size, livestock ownership, family size, risk perception, land tenure on non- arable lands, labour organization, characteristics of technology, indigenous institution and physical factors are significant determinants of SWC. He pointed out that farmers' SWC decision are affected by the interplay of social economic and institutional factors. Even though some factors are more important than others under a given situation, attention should be given to all of them in order to understand what farmers do in SWC.

Bekele and Holden (1998) used ordinal logit model to the study, the adoption of land conservation technologies in Andit Tid, North shewa. They found that peasants' decisions to retain conservation structures are positively and significantly related to soil erosion perceptions, attitudes towards new technologies, exposure to new practices, per capita availability of cultivable land, parcel area and slope, and productivity of technology.

A study conducted by Yitayal (2004) on determinants of use of soil conservation measures by small holders in Jimma zone, Dedo district, using Tobit model analysis, showed that, slope and distance of the farm plots significantly influenced the use of both traditional and improved soil conservation measures. Area of cultivated land increased the probability of using improved soil conservation measures especially, improved soil bund and cutoff drain. Farmer's age decreased the use of improved soil conservation structures while education level of head of house holds has positive impact on soil conservation. Extension education had a substantial contribution to motivate the use of improved soil conservation measures but, it had no effect on the use of traditional soil conservations practices. Land to labour ratio affected the use of both traditional and improved soil conservation practices.

A study conduct by Million (2001) on factors influencing adoption of soil conservation measures in southern Ethiopia: Gunvno area using binomial logit model showed that farmer's perception of soil erosion problem, technology attributes, the number of economically active family members, farm size, family size, wealth status of the farmer and the location of the farm land are influencing adoption of physical soil conservation measures in the study area.

A study conduct by Senait (2005) on determinants of choice of land management practices in North shewa zone, Ankober district, using multinomial logistic model showed that land owner ship type, distance of farm plot from home stead, resource availability and contact with extension agents were found to be the most important factors affecting choice of land management practices such as use of commercial fertilizer, manure, stone/soil bund or a combination of them. Strengthen the agricultural extension system and developing techniques that reduce the drudgery associated with manure application and bund construction are of great importance for the success of sustainable land management programs. Security of land owner ship encourages manure use and construction of soil conservation structures, but not the use of commercial fertilizer.

A study conducted by Mulugeta (1999) in central highlands of Ethiopia Salale area showed that land security, size of cultivated land, technology specific characteristics, formal schooling, wealth status of the household, availability of off-farm income and assistance from different sources were important determinants of adoption of physical soil conservation practices. A similar study by Adebabay (2003) in South Gonder zone, Farta district of Ethiopia reported that participation in conservation programs, land security, perception of soil erosion problem, the available land labour ratio and educational level of a household head were found to be important and significant factors for adoption of improved soil conservation technologies.

Berhanu and Swinton (2003) using a probit regression model undertook empirical study on the factors that determine the adoption of natural resource conservation at household and community level in the Northern Ethiopia region of Tigray. They found that land tenure security was a major factor that significantly conditions the conservation technology adoption.

2. METHODOLOGY

2.1. The Study Area

East Gojjam zone is one of the eleven zones of the Amhara regional state. It is located in the northern part of Ethiopia. The administrative zone is bounded by West Gojjam zone to the west, by Oromia region (Wollega) to the south, by South Wollo zone to the East and South Gondar zone to the North. It has a total area of 14705.36 sq. km, with an altitude ranging from800 to 4070 m.a.s.l. Its topography is estimated to be 48% mountainous, 12% rugged and40% gentle slope. It has also four agro climatic zones namely kola, woinadega, dega andwirch covering 16%, 37%, 45% and 2% of the total area, respectively. It receives a mean annual rain fall of 900 to 1800 mm and annual temperature of 8 to 27C^{o} .The zone is divided in to 16 rural and 1 urban districts with a total of 382 kebeles of which 36are urban kebeles. The estimated land use pattern of the zone shows that 30.2% is used for cultivation, 11.7% for grazing, 20.6% for forest bushes and shrubs and 37% for other purposes.

The study area Hulet Eju Enesie district (shown in fig.1) is one of the 17 districts of East Gojjam zone and found in the catchment area of chocke mountain; which is the water tower of blue nile river. It is 370 km far away to the north of Addis Ababa and 120 km to the south of Bahir-dar, along the main road from Addis Ababa to Bahir-dar through Motta. The district is divided in to 41peasant associations and 6 urban kebeles, with a total area of 1375.35 sq. km. Its altitude varies from 1288 to 3899 m.a.s.l. The topography of the district is estimated to be 55% gentle slope, 20% mountainous and 25% valley. It has three agro climatic zones Dega, Woinadega,and Kolla covering 18%, 52% and 30% of the total area, respectively.

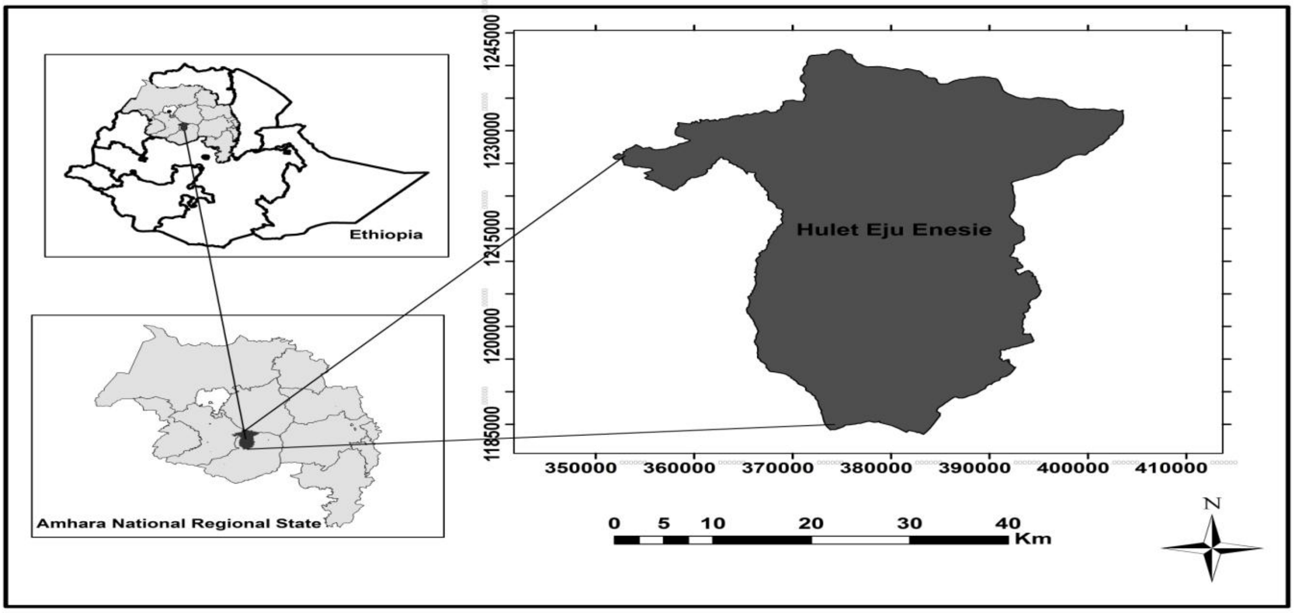

Fig.1 Map of the study area

The district receives a mean annual rain fall of 1100 to 1889 mm and a mean annual temperature 21 to 24 C^{o}. The major soil types of the district are red, black and brown which constitute 60, 10 and 30 percent of the total area respectively.

The extent of soil erosion by running water is aggravated by the limited availability of both physical and biological conservation practices in the area. Deforestation and poor vegetation cover is also a serious problem in the area.

Therefore, to minimize the problem of soil erosion and its effect on productivity and production of smallholder farmers in the area, natural resource development efforts have been made through office of agriculture.

The demand of forest products for fire wood, construction purposes and as source of income for poor farmers is increasing from time to time due to an increase in population. The continuous population growth has also created high demand for cultivable land that resulted in deforestation in the area. To reverse this situation certain activities have been under taken. The most important widely carried out activity was production and distribution of forest seedlings to the farm households for homestead and backyard plantation. Apart from redistribution of seedlings, provision of technical advice and training was an integral part of the forest development efforts of the extension programme.

2.2. Theoretical Frame Work and Hypothesis

Decision to use a technology depends on a wide variety of factors, many of which are specific to a particular village, household or plot. In general the decision of farmers over a given period of time is assumed to be derived from the maximization of a discounted utility of a farm profit from investment in soil conservations structures subject to household, economic and institutional factors. Farm profit is a function of inputs used in production including soil conservation structures. The farm household uses a given soil conservation technology, if a discounted expected utility obtained from use of technology is larger than with out the use of technology.

The decision to use is hypothesized to depend on the farmers' comparison of perceived net returns from the traditional (non-use) (t) and introduced (n) conservation technologies. Let the i^{th} farmer's perception of the net benefits from the use of the j^{th} technology (U_j) be a linear function of a set of explanatory variables ($\mathbf{X_i}$) and the stochastic element (V) such that

$$U_j = \beta_i X_i + v_j \qquad \text{For j = t, n.}$$

If Y^* is the unobservable variable that indexes use of technology, the observed response variable (Y) takes a positive value when use of technology occurs such that

$$Y = Y^* \text{ when } Y^* > 0 \text{ (or } U_n > U_t\text{)}$$

$$Y = 0 \text{ when } Y^* < 0 \text{ (or } U_n < U_t\text{).}$$

The probability that the new conservation technology might be used is given by

$$\text{P (V)} = Y^* = \text{P (} Y^* > 0\text{) = P (} U_n > U_t\text{)}$$

The adoption pattern of a technological change in agriculture is not uniform at farm level. It is a complex process which is governed by many factors. The farmers' socio psychological system and their degree of readiness and exposer to improved practices and ideas i.e. changes like the awareness and attitudes of farmers towards improved agricultural technologies and the institutional factors which act as incentives or disincentives to agricultural practices and the farmers' resource endowment like land holding size and labour are some of the factors that are of considerable importance to bringing about the technological change in agriculture (Aregay, 1979). Lapar and Pandey (1999) showed that adoption of conservation practices depends on plot farmer characteristics and the characteristics of the technology and the relative importance of these factors differs across sites.

Semgalawe (1998) also suggested that adoption of soil conservation technologies has been described based on varied criteria. These include type of conservation practices used, number of conservation practices used and land area under conservation measures. The most important observation is that these variables do not capture adoption in the same way. Therefore, the most critical issues in addressing soil conservation adoption behavior are how to define adoption and what should be used as the measure of adoption. The definition and approach chosen in many cases depend on the objective of the study and practical applicability of the criteria chosen. According to Feder *et al.* (1985) adoption process for innovation can be explained at individual household's level or at aggregate level. The individual household level approach analyses the behavior of single farm households towards adoption of technologies. The analysis often relates the degree of adoption to factors affecting it. The aggregate adoption approach is based on the assessment of the technology in a particular area.

Several literatures showed that one factor may enhance adoption of one technology in one area at one time and may hinder it in another situation, area and time. Therefore it is difficult to develop a one and unified adoption model in technology adoption process because of the socio economic and ecological variations of the different sites, and the various natures of the determinant factors.

Based on literature reviewed and authors experience the following independent variables were hypothesized:

Age of household head: This is a continuous independent variable measuring the age of a household head in years. On one hand, through experience, farmers may perceive and analyze the problem of soil erosion and opt to use soil conserving measures. Thus older age is often associated with long years of farming experience and could positively influence conservation decisions (Aklilu and Jan De, 2006). On the other hand, older farmers may be reluctant to adopt technologies easily than young farmers. Younger farmers were found to exert more effort on improved soil conservation methods (Yitayal, 2004). Thus, the effect of age of the farmer on conservation decision to use soil conservation technologies may be positive or negative (Baidu-Forson, 1999; Lapar and Pandey, 1999; Bekele and Derake, 2003) and its effect is indeterminate a priori.

Education: It refers to the educational status of the household head taking a value of 1 if the head of the household is literate and 0 otherwise. This is a proxy for the capacity of the head of a household to access and understand technical aspects related to soil erosion and soil conservation. Educated farmers can understand, analyze, and interpret the advantages of new technologies easily than uneducated farmers. Ervin and Ervin (1982), Samgalawe (1998), Paulos (2002) and Yitayal (2004) found a positive relationship between education and the decision to use conservation measures. Therefore, farmers who are literate are expected to be more likely to use soil- conserving technologies.

Social position in the kebele: It is a dummy variable which indicates the involvement of a household head in different administrative, religious and other matters in the community. It takes a value of 1, if a household head has social position in the community, 0 if not. Farmers who are involved in different administrative, religious and other matters in the community are more exposed to new information and technologies. Yitayal (2004) found a positive relationship between social position and the decision to use conservation technologies. Therefore, it is expected that a household head who is involved in different positions is more likely to use soil-conserving technologies.

Perception: It is a dummy variable used to measure farmer's perception of the presence of soil erosion problem in his/her plots. It takes a value of 1 if a household head perceive soil erosion problem in his/her farm plot, and 0 if not. A farmer who perceives presence of soil erosion on his plot and its effect on productivity is more likely to use conservation practices. Farmers' decision to retain conservation measures are positively and significantly related to perception of erosion problems on plots (Ervin and Ervin, 1982; Bekele and Holden, 1998; Paulos, 2002; Aklilu and Jan de, 2006). Therefore, it is hypothesized that farmers who perceive the problem of soil erosion are more likely to use soil conservation practices on their plots.

Area of cultivated land: This shows the total area of cultivated land of a household in hectares. Soil conservation structures may take some area that would have been used for cultivation (crop production). Farmers who operate on larger farms can allocate some part of their land to soil conservation structures than those who have small farms to soil conservation structures. Aklilu and Jan De (2006) in their study found that, farmers who hold large farms were found to be more likely to invest in conservation technologies. Therefore, it is hypothesized that farm size and the likelihood of using soil conserving technologies are positively related.

Livestock holding: This variable represents the livestock holding of a household in tropical livestock unit (TLU) and used as an indicator of wealth. Livestock are generally considered as asset that could be used in the production process or be exchanged for cash or other productive assets. More specialization in to livestock away from cropping may reduce the economic impact of soil erosion and thus lower the need for soil conservation (Bekele and Holden, 1998). Aklilu and Jan De (2006) also indicated that the effect of livestock on conservation decision is negative. On the other hand, those farmers who have large number of livestock may have more capital to invest in soil conservation practices. This affects soil conservation positively. Hence, the effect of the size of livestock holding on conservation decision is difficult to hypothesize a priori.

Land to labour ratio: Land to labour ratio is measured as the ratio of the area operated to the number of family members (in man-equivalent). As soil conservation is labour intensive large households will be able to provide the required labour force for the implementation of soil conserving structures. Yitayal (2004) found that higher Land labour ratio had negative influence on the use of conservation technologies. Therefore, in this study it is expected that higher land to labour ratio will be negatively related to the use of improved soil conservation technologies.

Off-farm income: This is the amount of money (in Birr) that a household obtains from off-farm activities annually. Participation in off-farm activities keep labour force needed for conservation away from the farm. Furthermore, short term benefit obtained from off-farm works may obscure the benefits accruing from investments in soil conservation. Many studies found negative relationship between off-farm income and farmers' conservation investment (Berhanu and Swinton, 2003; Pender and Kerr, 1997). By contrast, income from off-farm work may be used to hire labour for soil conservation. Therefore, the effect of off-farm work on conservation is difficult to determine a priori.

Security of land: It is a dummy variable, which is measures whether a household head feels that the can use the farmland for at least his/her life time or not. It takes a value of 1, if the farmer feels that he/she would able to use the land at least for his/her life time, and 0 other wise. It is expected that farmers make fewer long-term land improvements if they feel that the government in the future will redistribute land. The presence of land security may increase land improvement practices. Previous studies found a positive relationship between security of land and use soil conservation technologies (Aklilu and Jan de, 2006; Paulos, 2002). Therefore, it is hypothesized that long term land owner ship (land security) is positively related to conservation efforts. In this study, the farmer's feeling of using a given parcel at least during his/her lifetime was hypothesized to have a positive effect on his/her decision to participation in using soil conservation technologies on his/her plot.

Extension contact: This variable measures the average monthly frequency of contact that a household head has with development agents (DAs). Extension service provides the necessary information to acquire new skills and knowledge related to agriculture in general. Many studies have shown the positive relationship between extension contact and use of improved soil conservation technologies (Baidu-Forson, 1999; Semgalawe, 1998; Wagayehu, 2003). Therefore, it is expected that a household head that has greater contact with a development agent is more likely to use soil-conserving technologies.

Slope of farm plot: This is a dummy variable representing the slope category of a plot which takes a value of 1, if the slope is steep and 0 otherwise. The slope of land affects soil development both directly and indirectly. Steep slopes are susceptible to more rapid runoff surface water that might force a farmer to use soil conservation measures. The slope category of the plot has been found to be positively affecting the farmer's decision to invest in conservation technologies (Ervin and Ervin, 1982; Gould *et al*., 1989; Paulos, 2002; Wagayehu, 2003). Therefore, the slope of the farm plot is hypothesized to affect use of soil conservation technologies positively.

Distance of the farm: This variable refers to the distance of the farm plot from the residence of the farmers to the plot and measured in kilometers. Distance of the farm from the residence is hypothesized to influence soil conservation use decision negatively. This is because the closer the plot is to the residence area the closer supervision and attention it will get from the family. The time and energy they spend to reach on farm plots is lesser for nearer farms than distant farms. A negative relationship between distant of the farm and use of soil conservation technology had been reported by the study Wagayehu (2003) and Yitayal (2004).

The definition and units of measurement of the dependent and explanatory variables used in the two limit Tobit model is presented in Table 1.

Table 1. Definitions and units of measurement of variables included in the model

Variable	*Variable code*	*Type of variable*	**Unit of measurement**
Proportion of land under the technology	PRACUTEC	continuous	Measured in number
Area of total cultivated land	ATOCULA	Continuous	Measured in hectare
Labour man equivalent	LABMEQ	Continuous	Measured in number
Total cultivated land to labour	TLALABRA	continuous	Measured in number
Age of household head (years)	AHH	continuous	Measured in years

Educational level of a household head	EDUCTA	Dummy	1, if the house hold head is literate (read and write) and0, other wise
Distance of the a farm plot from residence	PLOTDIST	continuous	Measured in kilo meter
Livestock holding of a household head	TLU	continuous	Measured in tropical livestock unit (TLU)
Extension contact of a household head	EXTNCON	continuous	Measured in number
Annual off farm income of a household head	OFFFAIN	continuous	Measured in Birr
Slope category of a farm plot	SLOPE	Dummy	1, for steep, 0 other wise
Security of the land	LANDSECU	Dummy	1, if a farmer considered that he/she will use the plot at least during his/her lifetime, 0 other wise
Perception of a household head on soil erosion problem	PERCEPT	Dummy	1 if a household head perceives presence of soil erosion problem in his farm plot, 0 other wise
Social position of a household head	SOCPOSI	Dummy	1 if the household head has social position in the ***kebele,*** 0 other wise
Fertility category of a farm plot	FERTILITY	Dummy	1 if the fertility is high, 0 other wise

Fertility of land: This is a dummy variable that measures the fertility level of a plot which takes a value of 1, if the fertility is high and 0 otherwise. The effect of soil fertility on soil conservation decision may be positive or negative. On one hand, marginal productivity loss due to erosion is higher in high fertile soils than low fertile soils and farmers may give more attention to more fertile soils than less fertile one. Bekele and Drake (2003) found a positive influence of Soil fertility on conservation decision. On the other hand, the effect of high soil fertility on conservation decision is negative because farmers might not see the negative effects of erosion on their plots, at least in the short run, and the need for conservation reduce (Aklilu and Jan de, 2006). Therefore, the effect of fertility of a farm plot on conservation is difficult to determine a priori.

2.3. Sampling Design and Data Collection

The primary data required for this study were collected from 120 sample household heads through conducting formal survey based on structured questionnaire that was prepared in October and November 2007. Data were collected at household and plot level through enumerator's observation, measurement and interviews. Three-stage sampling technique was used to draw the sample respondents for the study. First, out of the total number of 41 ***kebeles (***the lowest level of administration in Ethiopia).in the district 37 of them were selected purposively. This has been done based on the discussion with the district agricultural and rural development department. Second, 4 ***kebeles*** were selected using simple random sampling technique. The sampling frame for each ***kebeles*** was obtained from recent documents of ***kebeles*** administration. Finally, probability proportional to size random sampling technique was used to draw individual sample household heads from each ***Kebeles.***

2.4. Analytical Methods

The qualitative and quantitative data obtained through data collected were analyzed using descriptive statistics and Econometric model. Descriptive statistics such as mean, standard deviation and percentage were used along with the econometric model to analyze the collected data.

Technology use studies based up on dichotomous regression models (LPM, Logit and Probit) explain only the probability of use and non-use rather than the extent and intensity of technology use. Knowledge that a farmer is using improved technology may not provide much information about a farmer's behavior because he/she may be using 1% to 100% of his/her farm for the new technology though, with respect to use of improved soil conservation technologies, a farmer may use on the whole, half or small proportion of the plot. A strictly dichotomous variable often is not sufficient to examine the extent or intensity of use the technology (Feder *et al.*, 1985). The application of Tobit model is preferred in such cases because it uses data at the limit as well as those above the limit to estimate the regression.

Therefore, a direct application of two-limit Tobit estimation sufficiently provides the needed information on the probability and intensity of using soil conservation measures because the dependent variable/proportion of land under the technology/ is continuous, but censored between zero and one.

The two-limit Tobit was originally presented by Rosett and Nelson (1975) and discussed in detail by Maddala (1992). The model is represented as:

$$
\begin{aligned}
&Y_i^* = \beta_i X_i + \varepsilon_i \qquad \text{i=1, 2, 3 ……….n}\\
&Y_i = L \text{, if } Y_i^* \leq L\\
&Y_i = Y_i^*, \text{ If } L < Y_i^* < U \qquad (1)\\
&Y_i = U \text{, if } Y_i^* \geq U
\end{aligned}
$$

Where

Y_i = the observed dependent variable, in our case the proportion of land under improved soil conservation technologies

Y_i^* = the latent variable which is not observable for values smaller than 0 and greater than 1 X_i = is a vector of independent variables (factors affecting use and use intensity of soil conservation technologies)

β_i = a vector of unknown parameter, and

ε_i = Residuals that are independently and normally distributed with mean zero and a common variance σ^2, and i= 1, 2…n (n is the number of observations).

L and U= indicate the lower and upper limit

The model parameters of Tobit estimated by ordinary least square (OLS) are biased and inconsistence. So the actual mechanism to estimate the Tobit model is the method of maximum likelihood (Gujarati, 2003).

The Likelihood functions of the two-limit Tobit model (Rosett and Nelson, 1975):

$$
L = \prod_L p\left(\frac{Y_i^* - L}{\sigma}\right) \prod_U F\left(\frac{Y_i^* - U}{\sigma}\right) \prod_I \frac{1}{\sigma} f\left(\frac{Y_i^* - Y}{\sigma}\right) \qquad (2)
$$

Where f and F are respectively, the density function and cumulative distribution function of Y_i^*, respectively and p is 1-F, I, represents the value between lower and upper limits

$\prod_{Y_i^* \geq U}$ is the product over those i for which $Y_i^* \geq U$

$\prod_{L < Y_i^* < U}$ is the product over those i for which $L < Y_i^* < U$

$\prod_{Y_i^* \leq L}$ is the product over those i for which $Y_i^* \leq L$

By using smallholder farmers in the study area the two-limit Tobit model, the ratio of plots covered with soil and water conservation technologies was regressed on the various factors hypothesized to influence the use of improved soil conservation technologies by.

Unlike traditional regression coefficients, the Tobit coefficients do not directly given the marginal effects of the associated explanatory variables on the dependent variable. But their signs show the direction of change in probability of use and the marginal intensity of use as the respective explanatory variable change (Amemiya, 1984; Goodwin, 1992;

Maddala, 1985; cited in Nknoya *et al*., 1997). In a Tobit equation each marginal effect includes both the influence of the explanatory variable on the probability of use as well as on the intensity of use. Hence, one has to compute the derivatives of the estimated Tobit model to predict the effects of changes in the exogenous variables.

In the case of a two-limit Tobit model the total marginal effect of a change in an independent variable X_i on the expected value of the extent of use of improved soil conservation structures (i.e. the percent of the acreage under the technology) has three components:
(i) The change in the probability of adoption weighted by the conditional expected value of the percent acreage under adoption given that the farmer has adopted,
(ii) The change in the percent acreage under adoption for farmers that are already adopted weighted by the probability of adoption, and
(iii) The change in the probability of adoption on 100 percent of the acreage

Mc Donald and Moffit (1980) proposed a useful decomposition of the marginal effects under the single Tobit which can be extended to the Two-limit Situations.

1. The marginal effect of an explanatory variable on the expected value of the dependent variable is;

$$\frac{\partial E(Y_i)}{\partial (X_i)} = \beta_i \left(F(Z_U) - F(Z_L)\right) \tag{4}$$

2. The change in the probability of using a conservation measures as independent variable X_i changes is:

$$\frac{\partial F(z)}{\partial (X_i)} = f(Z)\frac{\beta_i}{\sigma} \tag{5}$$

Where $\frac{\beta_i X_i}{\sigma}$ is denoted by Z

3. The change in the intensity use with respect to a unit change in an explanatory variable among non-complete users is:

$$\frac{\partial E\left(y_i / U > y_i^* > L, X\right)}{\partial X_i} = \beta_i \left(1 - \frac{Z_L f(Z_L) + Z_U f(Z_U)}{F(Z_u) - F(Z_L)} - \left[\frac{f(Z_L) - f(Z_U)}{F(Z_U) - F(Z_L)}\right]^2\right) \tag{6}$$

Where:
Z = is the Z score for the area under normal curve
X_i = explanatory variables
β_i = is a vector of Tobit maximum likelihood estimates and,
σ =is the standard error of the error term.

$$Z_L = \frac{L - X_i\beta}{\sigma}$$

$$Z_U = \frac{U - X_i\beta}{\sigma}$$

L and U are threshold values (L =0 and U =1) f and F are probability density and cumulative density functions of the standard normal distribution, respectively.

3. RESULT AND DISCUSSION

3.1. Descriptive analysis

Results of the study revealed 53.4% of sampled households used soil conservation structure at least in one of their plots. Soil and stone bunds were the major soil conservation structures used by sample households to reduce soil erosion. Their selection depends on the availability of construction materials in the plot area. From the total sample households 42.4%, 31.36% and 2.5% of them used improved soil bund, stone bund and waterways in one of their plots, respectively. In order to investigate the presence of group mean difference with respect to the hypothesized social, economic, institutional and physical factors uni-variate tests were used. Student's t-test and Chi-square statitistics were used, respectively to identify potential continuous and dummy variables differentiating users from non users. Users and non users significantly different in two of the Six hypothesized continuous socio-economic variables (Table 2).

Table 2. Continuous variables differentiating users from non users of improved physical soil conservation technologies among 118 sample households

Variable	*user*	*Non user*	*Total*	*t-value*
AHH	39.28	44.29	41.61	-2.091**
ATOCULA	1.24	1.09	1.17	1.351
OFFAIN	213.17	140.84	0.75	0.751
TLU	3.79	3.69	3.75	0.211
EXTNCON	0.96	0.70	0.84	1.771*
LABMEQ	2.6	2.48	2.561	0.67

*, **indicates Significant at 10%and 5% probability level respectively

The average age of the sample household heads was found to be 41.61 years ranging from 18 to 75 years with standard deviation of 13.10. Of the total sample household heads 35 percent of them have an age of greater than 45 years. The mean age of users and non users of improved soil conservation technologies are 39.29 and 44.29 years with standard deviation of 11.06 and 14.65, respectively. The mean age of users was found to be less than that of non users. The result of t-test showed that the mean difference of two groups was significance.

The survey results showed that landholding size of total sample households ranges from 0.125 to 3.25 ha with a mean of 1.29 and standard deviation of 0.59 ha. The average landholding size of users and non-users were 1.24 and 1.09 ha with a standard deviation of 0.65 and 0.51, respectively. Farm size of most farmers (53%) falls between 0.125 and 1 ha. It was found that only about 6% of the sample households have a farmland of above two hectares. There was a slight difference in the mean size of landholding between the two groups. However, the result of t-test showed that the mean landholding size difference between the two groups was insignificance.

The average size of livestock in TLU was found to be 3.75, 3.79 and 3.69 for total sample households, users and non users with a standard deviation of 2.53, 2.16 and 2.93, respectively. The difference between mean livestock holdings of users and non users of improved soil conservation technology was statistically insignificance. About 29% of total sample household heads has more than 5 TLU size of live stock.

Access to extension service is very important element of institutional support needed by farmers to enhance the use of agricultural technologies in general and soil conservation technologies in particular. Natural resource development agents were assigned in all sample PAs. It was expected that sample farmers in the study area have an access to extension services through the DAs, attending field days and training. However, about 17% of users, 40% of non user's have reported that they did not get extension services (visits) in the year 2006/07. About 56% of sample households had been visited by development agents from one to three times per month. The average monthly frequency of extension services/visits/ was found to be 0.97 and 0.70 for users and non users with a standard deviation of 0.80 and 0.83, respectively. The mean monthly extension visit difference of the two groups was found to be statistically significance.

The size of labour force in the household is assumed to bring about differences in decision of farmers to use improved soil conservation practices. Farmers with large household members will be able to supply the additional labour that might be required for soil conservation activities. However, the result of t-test showed that there was no significance difference in the mean size of labour force between users and non-users. The average available labour was estimated to be 2.56 man-days for total sample households, 2.62 man-days for users and 2.49 man-days for non-users, with a standard deviation of 1.08, 1.23, and 0.88, respectively.

In empirical studies users and non users not only differ interms of quantitative variables but also in terms of qualitative variables. It was, therefore, desirable to use a method of testing the differences between users and non users with respect to qualitative variables. Accordingly, the chi-square test was used to examine the presence or absence of differences between the two categories of farmers (Table 3).

Concerning the educational level of sample household heads, the survey results indicated that about 42% of the total respondents are illiterates, while the rest 58% of the respondents had various educational levels ranging from the ability to read and write up to 10th grade. About 30% of users and 56% non-users were illiterate farmers. The result of $\chi2$-test showed significance difference for distribution of illiterate and literate household heads of the two groups.

Table 3. Dummy variables differentiating users from non users of improved physical soil conservation technologies among 118 sample households

variable	*Score*	*User*	*Non user*	*Total*	X^2
EDUCAT	0	19	31	50	9.341***
	1	44	24	68	
LANDSECU	0	8	12	20	1.735
	1	55	43	98	
SOCPOSI	0	30	32	62	1.314
	1	33	23	56	
PERCEPT	0	11	11	22	0.125
	1	52	44	96	

*** Significant at 1% probability level

From the total sample household heads 83.05% believe that they can use the farmland for at least their lifetime. 6.35% of users and 5.45% of non-users replied that the land belong to them. About 32% and 62% of users believed that the land belongs to government and, about 20% and 75% of non-users believed that the land belongs for both government and them, respectively. The difference between the two groups in the perception of land security was found to be statistically insignificant. Regarding the social position of household heads 47.45 % of the total sampled households had a social position in the ***kebele***. The difference between the two groups in the social position in the ***kebele*** was found to be statistically insignificant.

Farmer's perception about the existence of soil erosion problem on their farm plots, causes of the problems as well as its consequences might make farmers to use improved soil conservation measures. The majority of the sample household heads (81.36%) have perceived the problem of soil erosion on their farm plots. From this, only 53.4% of households used soil conservation structure at least in one of their plots. About 18% of users and 20% of non-users were not able to recognize the problem. This shows that perceiving the problem of soil erosion problem is not always a guarantee to the use of improved soil conservation technologies. The difference between the two groups with respect to perceiving the existence of soil erosion problem on farm plots was statistically insignificant between the two groups.

Physical characteristics of farm plots such as slope, fertility and distance of farm plots from residence also other important factors which affects the use of improved soil conservation technologies. According to respondent's classification from a total of 382 farm plots managed by sample household heads, only 19.4% were flat. This implies that the rest 80.69% of farm plots need conservation structure of one kind or another. However, only 125(32.7%) plots had improved soil conservation structures.

Respondents have also rated their farm plots fertility in to three categories as low, medium and high. Based on this classification from the total number of farm plots about 23, 55 and 22 percent were considered as low, medium and high, respectively. From the total number of farm plots managed by users and non-users about 24% and 22% were considered as low fertile, respectively. The percentage of farm plots of users that were grouped as low fertile was slightly higher than that of non-users.

The average number of own farm plots for total sample households, users and non-users were 3.23, 3.49 and 2.94 with a standard deviation of 1.24, 1.25 and 1.17, respectively. The number of farm plots varies from one to six for sample households. The majority of the sample households (75.4%) have more than two farm plots. The distance of farm plots from residence is one of the factors that are expected to affect the use of improved soil conservation technologies. Thus, the mean distances for total farm plots, with and without soil conservation structures were found to be 1.18, 0.91 and 1.36 km with a standard deviation of 0.92, 0.83, and 0.94, respectively. The distance also varies from zero to five kilometers. The result of t-test showed that the mean distance difference between plots with and without soil conservation structures was found to be highly significant.

3.2. Econometric Analysis

3.2.1. *Determinants of Use of Improved Soil Conservation Technologies*

The major objective of this section is to identify important plot level and socio-economic institutional variables which affect farmers' decision to use soil conservation technologies. Before estimating the model using the hypothesized variables, it is crucial to check the problem of multicollinearity or association among potential explanatory variables. Towards this, multicollinearity problem for continuous explanatory variables was assessed using a technique of variance inflation factor (VIF). The degree of association between each dummy/discrete variable was assessed using contingency coefficient. Finally, the variables were considered for further analysis after verifying that multicollinearity is not a problem.

Two-limit Tobit model was used to analyze determinants of the probability to use and intensity of use of soil conservation technologies because, the dependent variable is the proportion of land under the improved soil conservation technologies, which is a continuous variable, but censored between 0 and 1. Generally, thirteen explanatory variables were included in the model to identify the determinants of the probability to use and intensity of use of improved soil conservation technologies. The chi-square value of a likelihood ratio is significant at less than one percent level of significance. This confirms the joint significance of the explanatory variables included in the model and shows existence of useful information in the estimated Tobit model.

The maximum likelihood Econometric Estimation method was used to estimate the coefficients of the explanatory variables in the two-limit Tobit model, using the proportion of land under the improved soil conservation technology as a proxy measure of conservation effort. Result of Tobit coefficients, their standard errors for improved soil conservation technologies is presented in Table 4. The dependent variable was measured in ratio (i.e. ratio of area covered by improved soil conservation technology to total area of the plot).

The results indicated that, among the 13 hypothesized explanatory variables included in the model, only six variables were found to be significantly affecting the use of improved soil conservation technologies in the study area. These are educational level of the household head (EDUCAT), distance of the plot from residence (PLOTDIS), livestock holding (TLU), extension contact (EXTNCON); slope of a farm plot (SLOPE) and fertility of a farm plot (FERTILITY). The coefficients of other seven variables were not statistically significant at the conventional probability levels implying that they were less important in effecting on farmers' improved soil conservation use decisions.

Among the explanatory variables included in the model, age of household head (AHH), distance of the plot from residence (PLOTDIS), livestock holding (TLU), off-farm income (OFFFAIN), land to labour ratio (TOCULALABR) and fertility of a farm plot (FERTILITY) were found to affect the use of improved soil conservation technologies negatively.

Table 4 also shows change in probability of use of improved soil conservation technologies as independent variable changes which can be interpreted as follows. For example, Education was found to affect the use of improved soil conservation technologies at 1% significance level and increase the probability of use by 20.75%. This implies that education may enable farmers too easily understand and recognize the problem of soil erosion, able to change in to practice the knowledge and skill they obtained from extension services and other sources.

Distance was found to decrease the probability of use of improved soil conservation technologies at 14.39%. This is because the time and energy farmers spend to reach farm plots is lesser for nearer farm plots than distant farm plots and also the closer the plot is to the residence area the closer supervision and attention it will get from family. The respondents' also noted that farm plots near to their residence are more convenient to use family labour early in the morning and in the evening.

Table 4. Maximum likelihood estimates of the two-limit Tobit model

Variable	*Coefficients*	*Standard error*	*t-value*	*Change in probability* $\frac{\partial F(z)}{\partial (X_i)} = f(z)\frac{B_i}{\sigma}$
Constant	-0.57591	0.56677	-1.02	-
AHH	-0.00837	0.00845	-0.99	-0.00244
EDUCAT	0.70943	0.21121	3.36***	0.20752
PLOTDIS	-0.49222	0.11517	-4.27***	-0.14398
TLU	-0.08021	0.04232	-1.90*	-0.02346
EXTNCON	0.30894	0.11415	2.71***	0.09037
OFFAIN	0.00005	0.00017	-0.32	-1.E-05
ATOCULA	0.32230	0.22997	1.4	0.09428
TOLALABR	-0.28384	0.51442	-0.55	-0.08303
SLOPE	0.67365	0.23066	2.92***	0.19706
LANDSECU	0.29880	0.24625	1.21	0.08740
PERCEPIN	0.24473	0.21999	1.11	0.07159
SOCPOSI	0.09925	0.19613	0.51	0.02903
FERTILITY	-0.56767	0.21957	-2.59***	-0.16606

Log likelihood function =-327.05868 F(z)= 0.5557
Number of observation =382 f (z) =0. 3951
Threshold values for the model: Lower=0, Upper=1
Z-score=0.147624 Likelihood ratio test= 74.88*
Sigma(σ)= 1.350641 Significance level = 0.0000
$F(Z_u)-F(Z_L)=0.1667$

*****,*** denote significant at 1% and 10% probability levels respectively
F(z), f(z) and z-score represent the cumulative normal distribution function, unit normal density function and z-score for the area under the normal curve, respectively.

Livestock constitutes an important component of the farming system in the area. However, the results of this study showed that livestock holding has a negative significant effect on the use of improved soil conservation technologies at 10 % significant level. A negative relation between livestock holding and conservation decision was also found by Aklilu and Jan de (2006). Livestock holding decreases the probability of use of improved soil conservation technologies by 2.34%. This indicates that large livestock size discourages farmers from engaging in conservation investments on plots for crop production due to the income they get from livestock. In addition, temporal yield gains through manure application might reduce potential productivity losses due to erosion, and thus reduce conservation efforts.

Frequency of extension contact was found to affect the use of improved soil conservation technologies positively and significantly at 1% significant level. As expected the sign of extension contact is in agreement with other adoption studies (Asfaw *et al*., 1997; Baidu-forson, 1999) that extension has positively correlation with conservation decision. Every contact of the farmer with the development agents increased the probability of use of improved soil conservation technologies by 9.03%. This indicates that farmers who have more contact with DAs would get the necessary information acquire new skills and knowledge to use conservation efforts.

Slope increases the probability of using improved soil conservation technologies by 19.7%. It implies that farmers are inclined to invest conservation practices where their farm plots are located in higher slopes. This is due to expectation of more benefits from conservation and high rate of soil loss on steeper slope farm plots than others. This means that on sloppy plot the impact of soil erosion would be more visible to the farmers and this force them to construct appropriate measures and take remedial action. This suggests that conservation efforts should target areas where expected benefits are higher, like on the steeper slopes, in order to encourage use of conservation technologies.

Fertility of farm plot decreases the probability of use of improved soil conservation technologies by 16.6%. This might be because of the fact that, farmers might not observe the negative effects of erosion in their fertile farm plots, at least in the short run and the need for conservation reduces. In addition the marginal benefit they got from investment of soil conservation technologies in high fertile plots is lower. The result is similar to the findings by Aklilu and Jan de (2006) that plots with fertile soils negatively influenced farmers' adoption of stone terraces.

The calculated derivative for the use of improved soil conservation technologies using two-limit Tobit model is also presented in Tables 5, which indicates the change in intensity of use with respect to change in an explanatory variable among complete users, non-complete users and the whole sample. The result should be interpreted as, for example, the marginal effect of educational level of a household head on the proportion of land under the improved soil conservation technology was 0.20 among non-complete users and 0.11 among the entire sample. This means the increment of proportion of land under improved soil conservation technologies for literate farmers is higher by 0.20 and 0.11 among non-complete users and the whole sample, respectively than illiterate farmers.

Table 5. Marginal effects of explanatory variables on proportion of land under improved soil conservation technologies.

Variable	*Effect of change In independent Variable on dependent Variable for observations at the lower limit* $(L-\mathrm{E}(Y*))\left(\frac{\partial F(Z)}{\partial X_i}\right)$	*Effect of change In independent Variable on dependent Variable for observations at the Upper limit* $(\mathrm{E}(Y*)-U)\left(\frac{\partial F(Z)}{\partial X_i}\right)$	*Effect of change in independent variable on dependent variable for non complete users* $\frac{\partial \mathrm{E}\left(y_i / U > y_i^* > L, X\right)}{\partial X_i}$	Effect of change inindependent variable on dependent variable for all observations $\frac{\partial E(Y_i)}{\partial (X_i)} = \beta_i(F(z_U)-F(z_L))$
AHH	-0.00167	-0.00207	-0.00240	-0.00139
EDUCAT	0.14209	0.17606	0.20375	0.11826
PLOTDIS	-0.09859	-0.12215	-0.14136	-0.08205
TLU	-0.01606	-0.01990	-0.02303	-0.01337
EXTNCON	0.06188	0.07667	0.08872	0.05150
OFFAIN	-0.00001	-0.00001	-0.00001	0.00000
ATOCULA	0.06455	0.07998	0.09256	0.05372
TOLALABR	-0.05685	-0.07044	-0.08152	-0.04731
SLOPE	0.13492	0.16718	0.19347	0.11229
LANDSECU	0.05985	0.07415	0.08581	0.04981
PERCEPIN	0.04902	0.06073	0.07028	0.04079
SOCPOSI	0.01987	0.02463	0.02850	0.01654
FERTILITY	-0.11370	-0.14088	-0.16303	-0.09463

The marginal effect of distance of farm plot from residence on the proportion of land under the improved soil conservation technology was 0.14 among non-complete users and 0.08 among the entire sample. An increase in distance of farm plot by one kilometer would decrease the proportion of land under the improved soil conservation technology by 0.14 and 0.08 units for among non-complete users of the technology and among the entire sample respectively.

4. CONCLUSION AND RECOMMENDATIONS

Land degradation in general and soil erosion in particular is a major constraint of agricultural production. Realizing this fact, different stake holders (government and non government organizations) involved in rural development are highly concerned with the problem of soil erosion have been undertaking considerable measures to increase agricultural production and maintain the existing natural resource base of the country. However, these stack holders need to understand, factors influencing farmers' use of soil conservation measures, to develop appropriate technologies and design effective policies and strategies, that promote resource conserving and productive land use.

The finding of this study, therefore, would provide first hand information on the factors influencing the use of improved soil conservation technologies for different government and non government organizations, extension agents working in the study area and other similar areas. Researchers would also used as stand point for further detail investigation. Analysis of cross sectional survey data based on a sample of 118 households managing on 382 farm plots in Hulet Eju Enesie district, East Gojjam zone in 2007 showed that educational level of a household head (EDUCAT); distance of the plot from residence (PLOTDIS); livestock holding (TLU), extension contact (EXTNCON); slope of the plot (SLOPE) and fertility of farm plot (FERTILITY) affect farmers conservation diction and extent of use of improved soil conservation technologies.

Based on the findings of the study the following points need to be considered as possible policy recommendations in order to enhance the use of improved soil conservation technologies.

The findings of the study show that even if, the majority of the sample household heads have perceived the problem of soil erosion on their farm plots, farmers' perception on the problem of soil erosion on their farm plots was not significant on probability and intensity use of improved soil conservation technologies. This might be due to lack of willingness and/or ability of farmers to use improved soil conservation technologies. Thus, to encourage use of improved soil conservation technologies agricultural extension and projects which, promote soil and water conservation technologies, should have strategies which focus on enhancing the willingness and/or ability of farm household heads to use improved soil conservation technologies.

Educational level of a household head has a significant and positive relation with use of improved soil conservation technologies. Therefore, Bureau of Agriculture should strengthen educational opportunities through facilitating the establishment of farmers training center and their operation in rural areas of the administration.

The extension visit was an important variable affecting the probability and intensity of using improved soil conservation technologies positively. Therefore, to sustain the positive contribution of the extension service, to the use and use intensity of soil conservation technology Bureau of Agriculture should strengthen the extension contact between farmers and development agents by strengthen agricultural technology outreach services and capacity of working development agents. In addition, deploying adequately trained development agents in adequate numbers to the rural areas would increase the contact and flow of information between the DA and the farmer that would improve use of improved soil conservation technologies.

Livestock production is an important component of the farming system in the area since farming is integrated with crop and livestock production. Livestock holding affects the use of improved soil conservation technologies negatively. This implies that more specialization in to livestock away from cropping may reduce the economic impact of soil loss on the family income and lower the need for soil conservation. Thus development agents should provide farmers that own relatively large number of livestock with information on long term impacts of soil erosion on household income and its impact for future generation.

Fertility of a farm plot affected the probability and intensity use of improved soil conservation technologies negatively. It implies that farmers are inclined to invest conservation practices where the fertility of their farm plots is low and higher slopes. This is because of that, farmers did not see the negative effects of erosion in their farm plots, at least in the short run. This suggests that development partners should have to give greater attention in conserving fertile plots before they lose their fertility. Priority should, therefore, be given to providing farmers with information on long term impact of soil erosion on the present fertile plots.

Soil erosion a serious problem in the region in general and in the study area in particular. Much of the top soil has lost and the productivity of the land has seriously declined from time to time in line with an increase in population. This suggests a shift in emphasis by concerned organizations and government bodies involved in soil conservation to give greater attention in conserving soils before the land loses its potential rather than targeting on lands that has been already exhausted and degraded.

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