




## FACTORS INFLUENCING FARMERS' ADOPTION OF SOIL CONSERVATION DEVELOPMENT

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### ABSTRACT

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Landscape degradation by soil erosion has increased considerably in Ethiopian lands due to deforestation of natural mountain forests and the cultivation of large areas resulting in a serious environmental problem threatening the sustainability of agriculture and population food security. In Boset Wareda (in Ethiopia), farmers are producing for subsistence and exerting an increasing erosion of the land. Nevertheless, soil and water resources degradation addicted by natural and anthropologic activities are usually controlled by soil conservation techniques and water harvesting constructions. This study has contributed knowledge on social, economic and technical factors affecting adoption of CTs among household farmers in Ethiopia. CT development in the rural sector is not possible without addressing the current challenges identified in this study such as household heads farming experience, household size, and access to extension services, high costs of adoption, labour costs, and size of land owned by a household head. To reach this goal, econometrics analysis was derived from cross-sectional data for a single time period of production. Probit and Tobit models were econometrically estimated to evaluate rate of adoption (i.e., participation in conservation techniques) and intensity of adoption (i.e., allocation of land for conservation techniques) by the interviewee farmers.

**Contribution/Originality:** This study contributes to the existing literature about the willingness of farmers to adopt soil and water conservation techniques. This study uses estimation methodology using econometric models: Tobit and Probit. The paper's primary contribution is finding that some farmers are not aware about erosion and land degradation problems. While other farmers are aware but financial and material constraints discourage them to install these conservations facilities.

### 1. INTRODUCTION

Water erosion, drought and famine have frequently occurred in Ethiopia. In fact, Ethiopia is an African mountainous country with highly erodible soils on steeply sloping land and is losing from its topsoil about 1.5 billion tons per year, washed away by rain according to Ademola, Paul, and Vlek (2008). Most areas in Ethiopia are eroded because they are repeatedly cultivated or frequently suggested to grazing such as shrublands and grasslands. This is particularly the case of the visited farmlands in Boset Wareda. This later is a heart-located area of Ethiopia making part of East Shewa Zone in Oromia Region. Nonetheless, natural resources conservation strategies have been undertaken at the national, regional and local levels to halt the stretch of land degradation. In

fact, it has been proven that soil erosion can be limited with proper management of vegetation, plant residue and tillage (Lee, 2004). The study site of Boset Wereda was selected purposively for this research because conservation techniques in farming activities have been growing practices in the area. It is characterised with both socioeconomic and agricultural issues with threat of water and soil erosion which had led to desertification, drought and rural financial deficiency. In fact, food security is of major concern and obstacle of the welfare of rural population and some socioeconomic and agricultural practices had impact on poverty.

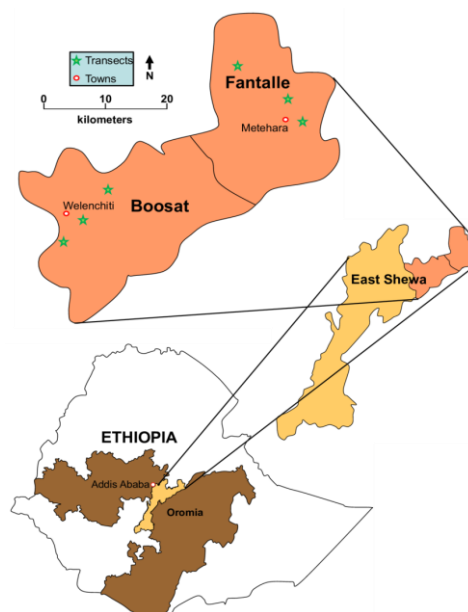
## 2. OBJECTIVES

In this research we attempt to state the socio-economic variables that explicate why some Ethiopian farmers accept to adopt soil conservation strategy while others do not. That is to say, we aim to find out what are the factors affecting the adoption decision and at which intensity. To reach these goals, we supposed and tested out 5 hypotheses using Tobit and Probit models. Previously we selected the site for the case study in order to identify areas with variation over space in soil and water conservation techniques (CTs) and with good potential collaborators to conduct the study. To study the impact of CTs on farm productivity, it was necessary to look for situations where some identifiable difference in CTs adoption was evident. Three steps were followed: look at areas where there had been adoption of CTs from initiative and payment of farmers or government or NGOs; choose the adoption of CTs done with the initiative and budget of farmers; and establish the econometric analysis based on farmers situation.

## 3. METHODOLOGY

### 3.1. Description of the Research Zone

In this study, we carried out an area frame in Boset Wereda located at East Showa zone, central Ethiopia [Figure 1](#). The estimated area is about 1,462 square kilometres. The 2005 national census reported a total population is of 158,253, of whom more than two-third are rural (Adama Agricultural Office, 2009). Annual average temperature ranges between 20°C and 28°C and the average annual precipitation ranges between 600-900 mm. Due to its location on the Great Rift Valley Boset area landscape is harshly undulating with sparse vegetation and highly covered with stones. The agricultural production is mainly: sorghum, haricot beans, maize, barley, café, teff, fruit trees such as mango, papaya, etc.



**Figure-1.** Boset wereda map at East Shewa zone (in the center of Ethiopia).

Source: Debela, Njoka, Asfaw, and Nyangito (2012).

### 3.2. Sampling Procedures and Data Collection

From the visit of the area, it was noted that different kind of farmers' organisations to establish these CTs in groups, community or individual basis existed in the research area. For the purpose of this study, we selected farmers who have done the CTs by their own budget and individually. Structured household questionnaire was used for collection of primary data. The questionnaire was designed to capture both quantitative and qualitative data. Both closed and open-ended questions were used.

The questionnaire was divided into 7 sections to capture data related to demographic, crop and breed activities, water and resources, and extra-agricultural activities and conservation techniques. The questionnaire was pre-tested in order to test the appropriateness of the data collection instrument, the extent to which households would cooperate and respond to it, the extent of the field researchers' understanding in gathering the required information and to get feedback from households to minimise the possibility of systematic errors of interpretation. The testing was very useful and resulted in substantial improvements of the design.

A checklist was prepared to obtain background information necessary collected from the Boset Wareda District, Rural Development Zonal Office of Adama, Adama Meteorological Service Agency, Ethiopian Mapping Agency and the Ministry of Agriculture, etc. The checklist comprised both socioeconomic and physical information. The data was then analysed and lead to choose the study site. The list was adapted and prepared for the desired purpose. The sample size was therefore fixed at 145 farmers.

### 3.3. Data Analysis

Data entry and analysis began shortly after the fieldwork and data was edited by using SPSS. Both quantitative and qualitative descriptive statistics were used to summarise survey results. However, to test hypotheses econometric procedures were also employed to examine variables influencing households' rate and intensity of adoption of conservation techniques (CTs) among sampled respondents.

To examine the determinants affecting CTs adoption (rate of adoption), a dummy variable,  $W_{ij}$  was used, which takes one if household head  $i$  of household  $j$  use CTs and zero otherwise, and estimated the Probit model specified in Equation 1. Note that Probit model express the marginal probability of adopting the technique or not by explaining the causes affecting this probability; example: education, age, extension services, might affect positively the probability of adopting CTs.

$$\text{Probit}(W_{ij} = 1) = f(C_{ij}, H_j, X_j) \quad (1)$$

Where  $C_{ij}$  is a set of characteristics of household heads  $i$  of household  $j$ ; (e.g., age, gender, education, household head farming experience (years), etc),  $H_j$  is a set of household characteristics; (e.g., household size, labour availability, land tenure, etc) and  $X_j$  is a set of household farming system (e.g., size of farm under CTs in ha, total costs in birr of CTs per ha, access to extension services, etc).

On the other hand, Tobit model (Tobin, 1958) in Equation 2 was used to analyse the factors affecting intensity of adoption. Tobit model was used since the proportion of land allocated for CTs was a continuous variable truncated between zero and one. Ordinary Least Square (OLS) regressions will result in biased estimates (Cameron & Trivedi, 2009; McDonald & Moffitt, 1980).

$$\text{Tobit}(0 \leq Y_{ij} \leq 1) = f(C_{ij}, H_j, X_j) \quad (2)$$

### 3.4. Tested Hypotheses

Based on the specific objectives designed for this study, theoretical framework and empirical literature review, the following testable hypotheses were constructed and tested:

- (i) *Hypothesis I:* An experienced household's head in farming activities is more to be expected to adopt CTs and give more land under CTs to increase farm productivity.

- (ii) *Hypothesis II*: Having schooling education increases a household head's ability to acquire information pertinent to CTs production systems and therefore education increases the rate and intensity probability of adoption.
- (iii) *Hypothesis III*: Access to extension services increases the probability that a household head  $i$  of household  $j$  adopt CTs.
- (iv) *Hypothesis IV*: The marginal likelihood that a household head  $i$  of household  $j$  adopts CTs increases with a unit increase in households' size.
- (v) *Hypothesis V*: Unit cost of adoption in terms of CTs production system influences probability of adoption in a negative direction.

## 4. RESULTS AND DISCUSSION

### 4.1. Determination of Sample Size

Household sample size was determined by using Equation 3 in which  $N_1$  is the required sample size without finite population correction factor (FPCF),  $Z$  is the confidence level at 95% (standard value of 1.96),  $p$  is an estimated proportion of an attribute and  $\Phi$  is the margin of error at 5% (standard value of 0.05). It was estimated that about 95% population in the study area engage in farming activities and taking into account number of farmers in the five villages with potential to adopt CTs ( $N_2$ ) being equal to 9000 (Adama Agricultural Office, 2009) according to Kothari, Loutskina, and Nikolaev (2006) it followed therefore that:

$$N_1 = \frac{Z^2 p (1-p)}{\Phi^2} = \frac{(1.96)^2 (0.95)(1-0.95)}{(0.05)^2} = 72.9904 \quad (3)$$

Given sample size provides proportionately more information for a small population than for a large population, therefore, applying the finite population correction factor (Kothari et al., 2006) resulted in the actual sample size  $N_3$  computed in Equation 4.

$$N_3 = \left( \frac{N_1 N_2}{N_1 + (N_2 - 1)} \right) = \frac{(72.9904)(9000)}{72.9904 + (9000 - 1)} = 72.41119 \quad (4)$$

The survey was designed as a cluster sample (a representative selection of villages), not a simple random sample, hence to correct for the difference in the design, the sample size was multiplied by the design effect ( $D$ ) in Equation 5. The value of  $D$  was assumed to be 2 for village surveys using cluster-sampling methodology as IFAD (2003) and FAO (1997) attest.

$$N = (D)(N_3) = 2(72.41119) = 144.8224 \approx 145 \quad (5)$$

Sample size of 145 households was purposively distributed to five villages by equal allocation of 29 households. A total of 120 households usable questionnaires were recorded (representing a village survey response rate of 82.76 percent) which is satisfactory for this research.

### 4.2. Definition of Variables Used in the Tobit and Probit Models

The Table 1 presents the different variables that have been used in Tobit and Probit models.

Table-1. Described variables.

Variable	Definition of the variable	Description
$W_{ij}$	1 if household head $i$ of household $j$ use CTs 0 if not	Dummy
$Y_{ij}$	proportion of land assigned for CTs (truncated between 0 and 1)	Continuous
<b>Household heads' characteristics</b>		
G H	gender of household head, 1 if male 0 otherwise	Dummy
H exp	household heads farming experience (in years)	Continuous
Educ H	household head's school education years	Continuous
Age H	household heads age	Continuous
<b>Households characteristics</b>		
Fsize	household size (number of members in a household)	Continuous
Farmsize	land size owned by a household head	Continuous
<b>Household farming system</b>		
drought	1 if drought is a problem, 0 otherwise	Dummy
CT cost	cost of adoption in birr	Continuous
Wtp	farmers willingness to pay (in birr)	Continuous
Tsoil	dummy variable 1 for clay, 0 otherwise	Dummy
Dslope	slope of land measured in percent	Continuous
Vegco	vegetation cover in percent	Continuous
Ext prg	1 for farmers received extension programs, 0 if not	Dummy
Lab cost	labour cost in birr	Continuous

#### 4.3. Definition of Factors that Influence Farmers Willing to Adopt Soil Conservation Amenities

The household level factors affecting CTs adoption appear to be household heads farming experience, education (household head's years of schooling), household size, land size, cost of adoption, access to extension services and labour cost.

Households' heads farming experience was highly statistically significant ( $p < 0.001$ ) implying that one-year increase in years of household head's farming experience increases the probability of adopting CTs by 22.22 percent holding other factors constant. Besides, everything else being given, one-year increase in years of household head's farming experience increases land allocation under CTs (intensity of adoption) by 0.032 ha, therefore supporting hypothesis I. This is consistent with Otsuka, Estudillo, and Sawada (2008) which shows that household's heads farming experience affects decision significantly on rate and intensity of adoption of new farming technologies. This could be explained by the fact that experienced household farmers are likely to benefit the emerging farming opportunities and hence opt to participate because they are better settled in the area, well known and likely to be trustworthy by credit providers, among others. This is not the case with less experienced farmers who are perceived as high-risk taking clients.

Increase in one year of school education increases the probability of CTs adoption by 1.4 percent whereas access to extension services increases the likelihood of adoption by 37.1 percent hence supporting hypotheses II and III respectively. It can be inferred that household heads with several extension contacts had higher probability to adopt CTs in the study area than their counterparts. These variables also have positive and significant effect on the intensity of adoption.

Household heads' owning sizeable land have a consistently positive relationship to CTs adoption decisions. Other factors being given, increase in land size owned by one ha increases the probability of adoption by 3.2 percent.

As expected, coefficients of costs of adoption in both cases were respectively negative and statistically significant thereby supporting hypothesis V. One unit increase in cost of CTs adoption reduces the probability of adoption by 5.0 percent whereas it reduces the size of land allocated under CTs by 0.09 ha, *ceteris paribus*.

Household size was found to be positive and significantly related to both rate and intensity of CTs adoption thereby showing that increase of household size by one person increases adoption attitude by 27.23 percent and allocation of land under CTs by 0.034 ha keeping other factors constant. This implies that household head size

matters a lot in adopting CTs farming system as this was explained in the field by interviewees that it is an alternative source of labour. However, this observation is not in favour to other adoption studies (e.g., Mathania (2007)) who pointed out that increasing household size (especially children in rural sector) only presents a burden and not labour supply to the household heads as they need support.

On the other hand, labour cost had significant and negative result showing that increasing labour cost by one birr reduced probability of CTs adoption on average by 1.67 percent, thus supporting hypothesis *V*. Similarly, one-birr augmentation in labour cost results in 0.03 ha decrease in land allocated for CTs on average.

The Table 2 summarizes the results found out from Tobit and Probit models.

**Table-2.** Impact of the independent variables on probability and intensity of CT adoption.

Abbreviation	Independent variables	Adoption probability (W)	Adoption intensity (Y)
<i>H exp</i>	household experience	+22%	+0.039%
<i>Educ H</i>	household school education	+14%	+0.31%
<i>F size</i>	household family member	+27%	+0.34%
<i>Farm size</i>	land size (ha)	+0.31%	+0.23%
<i>CT cost</i>	CT cost (birr)	-0.5%	-0.0009%
<i>Ext prg</i>	extension programs	+37%	+0.3%
<i>Lab cost</i>	labor cost (birr)	-17%	-0.3%

#### 4.4. Discussions

Contextual and technical reasons explain why some farmers are restraint to practice the conservation techniques. One of the obstacles is the land tenure insecurity, in fact, land tenure rights are predisposed to unpredictable modifications; also land ownership title is not clear these reasons make farmers uncertain about future and cannot invest in project that offer profit at the long run and thus they may be reluctant to adopt a sustainable land management, most of the farmers still feel uncertain and ambivalent about land ownership (Tekle, 1999).

Above and beyond, inaccessibility to technical information and assistance for getting theoretical and practical advices and recommendation explain the non-adoption of farmers to CT. Only few farmers are well informed and obtained good supervision about improved technologies from DAs (development agents), including improved soil conservation techniques and technologies. But most of farmers complain that they receive only theoretical advices but the practical advices are missing. That makes difficult to apply in reality. Others say they are very rarely visited by DAs or they have no contact with any advisor organization.

Moreover, land fragmentation, land scarcity problem and big distance between farm plots make hard investing in small lands and moving from plot to plot. In fact, according to farmers, the reasons of reduced harvest are land fragmentation due to human pressure and land inheritance from one hand, and to the decline of soil fertility due to erosion and frequent drought on the other hand. Land fragmentation has the disadvantage that the land faces the risk of crop failure, and that it implies more time and transportation difficulties of inputs, equipment and crop products to move from a different farm's plots. But the fragmentation has the advantage to lead to a crop diversification due to the existence of different micro-ecological spaces. This spread of crop-strategy leads to minimizing the risk, and thus to a better income.

Also, this area is characterized by harsh topography which restrains the implementation of water and soil conservation facilities.

Besides, there is problem of financing labor which is more likely the financial deficiency to pay the hired labor rather than the labor availability problem in addition of the lack of credit. Accordingly, SWCT are costly for poor rural households whether for workforce or equipment and material such as gabion and rocks. Thus, investments in SWCT often decrease immediate benefits. In fact, opting for conservation techniques requires scarifying short-term gain for long-term benefits especially that conservation amenities did not contribute to increased yields at short term.

What's more, the conservation facilities occupied some land and thus reduced the useful agricultural surface. Therefore, money, time, land space and labor consuming for the farmer conferred to the small-sized land make it not worthy to install CTs. Moreover, conservation amenities collected fertile soil which could be useful to increase short term production. In addition, CTs could host rats that may harm the crops and water ponds could attract insects and mosquitos.

## 5. CONCLUSION

Agriculture technologies are by far the most important sources of sector growth and livelihood of the poor in many rural parts of developing countries and Ethiopia in particular. Adoption of conservation techniques (CTs) presents a great potential for enhancing rural livelihoods and reducing rural poverty. The likely outcome of this, unless addressed, will be a decreasing number of rural households' participation in CTs farming, declining crop yield, and eventually worsening income poverty. The main objective of agricultural development is to improve rural welfare. This is achieved primarily through increases in small-farm income, productivity and genuine food security. So, addressing constraints affecting adoption of CTs in farm production is essential for poverty alleviation and enhancing rural livelihoods.

Whereas at macro-level, the importance of CTs sector in the study area has been recognised towards market-based directions, yet there is a need to improve linkage between line Ministries and the local government authorities at district level to enable micro-institutional arrangements provide a framework favouring a well-functioning CTs not only in agriculture but also for environmental conservation. There is a need to formulate and implement pro-CTs strategies around which a synergistic public-private sector partnership could develop and encourage stakeholders understand the need and participate in CTs farming system.

State should provide more training or extension services for farmers and assist them to opt for CTs in their farm businesses. This will increase productivity and profitability of crops. Therefore, sharing experiences between farmers would be a fundamental way to encourage farmers to adopt CTs in case of deficiency or absence of extension support organization. There is also a great need for clearer policy about land ownership and market transactions. The high cost (of labour-force and materials) should be resolved or alleviated to help farmer to take on these strategies as results obtained from Tobit and Probit models. These models commended that the option for CT adoption and intensity of adoption is related and addicted also by the household size and by the household head experience and education.

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