Determinants of Adoption of Soil and Water Conservation Practices in Ethiopia

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Abstract

This study, undertaken in the environs of Simen Mountain National Park of Amhara state attempts to identify determinants and extent of adoption of soil and water conservation technologies. Both qualitative and quantitative methods were used in the study. Descriptive statistics and a logistic model were employed to identify the factors, which determine adoption of soil and water conservation practices. It is evident from this study that socio economic and institutional factors influence the level of investment households commit to soil and water conservation. The result shows that the explanatory variables viz., the number of years the household made farming as a living, the total household labor and visit of the extension agent are significantly related to adoption of soil and water conservation practices by the farmers.

1. Introduction

1.1. Background

Ethiopia is a country endowed with a favorable natural environment for production of various crops and livestock. The agricultural sector accounts for nearly 45 per cent of the GDP and provides employment to more than 80 per cent of the population. (EEA, 2004).

Though land provides a means of livelihood for the majority of the population of the country, land resources are facing increasing degradation mainly due to water erosion in the form of sheet and rill erosion (Hurni, 1993).

The environs of Simen Mountains National Park is also under similar threat because of cultivation using the typical agricultural practices in the north. Degradation of natural resources, particularly vegetation and soil, is wide spread and leads to a chronic food deficit under present standards of mountain agriculture (Hurni and Ludi, 2000).

Soil erosion is very pronounced in the entire study area, particularly on cultivated land. Without protective measures, the maintenance of the livelihood

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of the people in the area would not be guaranteed because of the depletion of natural resources (Ibid.).

Therefore, understanding farmers' land management behavior in the environs of Simen Mountain National Park is of paramount importance and hence the study was taken up.

1.2. Objectives of the Study

The objective of the study was to identify determinants and extent of adoption of soil and water conservation technologies.

2. Literature Review

Adoption Pattern and Empirical Studies on the Adoption of Agricultural Technologies

Colman and Young (1989) define adoption as it relates to the use or non- use of a particular innovation by individuals (farmers) at a point in time or during an extended period of time.

The importance of agricultural innovations in the transformation process of economies of developing countries has become, without doubt, the major concern of governments, citizens and development agencies alike. Agricultural economists in the development field have made a study of the adoption and diffusion of technical innovations because of the opportunities for increased output and higher levels of income which technological change can offer (Ibid.).

A number of research studies on adoption behavior pointed out that a host of explanatory factors influence adoption behavior of farmers. For instance, Ebrahim (2006), Kebede (2006), Rehmeto (2007), and Taha (2007) identified factors such as demographic characteristics, institutional characteristics, and innovation characteristics and socio-economic factors as influencing the adoption of technologies.

Getahun (2002) has carried out a study on factors influencing farmers' willingness to pay for soil conservation technologies in western Hararghe highlands, Ethiopia. The results of the logit model indicated that, age, livestock holding and total household labor in man equivalent were the most significant variables to affect willingness to pay for soil conservation technologies.

Therefore, the above evidence and review of studies signify the importance of location specific studies to identify the major factors, which are barriers to the adoption of a technology, and to recommend on the basis of the results for better achievement.

3. Research Methods

Both qualitative and quantitative methods of data collection were used in the study. Primary as well as secondary data sources were used to achieve the research objectives. Primary data sources were sampled households and key informants, while secondary data sources were documents, and reports of different relevant organizations. Qualitative data were gathered though focused group discussions and informal interviews with key informants.

Structured interview schedule was used to conduct the survey among sampled households. Multi stage sampling procedure was used to select the respondent farmers. In the first stage, two districts were purposely selected out of three based on accessibility. In the second stage, four Keble Administrations (KAs) out of 17 in the two districts were randomly selected. Keble Administration is similar to "Villages" or "Rural community". The four KAs included a total of 3983 households. Among them, 2483 households (62 percent) were participants in food for work or mass mobilization and the remaining 1500 households (38 percent) were either technology users or non users. These 1500 households formed the sampling frame for the study. From this, 120 households were randomly selected using Probability Proportional to Size sampling technique.

Descriptive statistics such as mean, standard deviation, frequencies and percentages were used along with Binary logit model to identify the determinants of adoption of the technology.

4. Results and Discussion

4.1. Determinants of Adoption of Soil and Water Conservation

A logit model is applied to estimate the effect of the hypothesized explanatory variables on the probabilities of adoption of soil and water conservation practices, looking closely into the relation of the dependent variable to the explanatory variables for a household which has either adopted them or not. For that matter, adoption of soil and water conservation practices acted as a dichotomous dependent variable with an expected mean value of 1 to represent the adoption of soil and water conservation practices and 0 otherwise. For this purpose, 11 explanatory variables were selected. Summaries of these variables are presented in table 1.

Table 1: Summary of Variables used in Logistic Regression Model

Variables	Value	% with value 1	Mean		
			TU[a]	NTU[b]	Total
EDULHH	Educational level of the household in schooling years		1.73	1.77	1.74
FEXPER	The number of years a household head was involved in farming		22	30	25
TLABME	The total household labour in man equivalent		3.529	2.026	2.99
FARMSH	The total area of cultivated and fallow land		0.773	0.591	0.708
SLPOPE	Slope category of the farm; 1 if the slope category of the farm is found gentle slope to very steep; 0 otherwise	77.5			
LISECURIT	Security of tenure, 1 if the farmer feels that land belongs to him or her at least in his/her lifetime; 0 otherwise.	93			
EAVISIT	The frequency of visit to the farmer by the development agent		11.01	2.7	8.03
TLU	The total livestock unit in TLU		3.769	2.647	3.367
PRONE	Steep land prone to soil erosion; 1 if steep land is prone to soil erosion; 0 otherwise	70.833			
SERIOUS	Farmers' level of perception on soil erosion;1 if moderate to severe; 0 otherwise	81.666			
PERCESWC	Perception of SWC technologies on increasing productivity of the land	93.3			

[a] Technology users

[b] Non-technology users

Variable inflation factor for continuous variables and contingency coefficients for the discrete variables are used to assess the degree of association or multi co linearity among those look likes, for the explanatory variables, to estimate the model.

VIF (Xi) shows how the variance of an estimator is inflated by the presence of multi co-linearity, which is defined as:

VIF (Xi) = $1/1\text{-}R^2$, where R^2 is the adjusted value (Gujrati, 1995).

VIF is calculated for each explanatory variable, which shows the variance inflation factor when i^{th} explanatory variable is regressed on all other explanatory variables. R^2 measures the coefficient of determination of this regression. When adjusted R^2 approaches 1, the VIF approaches infinity, which means that, as the extent of co linearity increases, the variance of estimator increases, which in the limit becomes infinite. If there is no co linearity between repressors, VIF will be 1. If the VIF of a variable exceeds 10, which will happen when R^2 exceeds 0.90, then variable is said to be highly collinear and it can be concluded that multi co linearity is a problem (Gujrati, 1995).

Following the above procedures, the variables have no problem of multi co linearity, as the value of VIF is by far less than 10 for all variables. For that matter, all quantitative explanatory variables are added in the logit model (table 2).

Table 2: Variable Inflation Factor of the Continuous Explanatory Variables

Variables	Adjusted R^2	VIF $(1\text{-}R^2)$-
EDULHH	0.121	1.138
TLABOME	0.491	1.965
FARMSH	0.185	1.227
EAVISIT	0.092	1.101
FEXPER	0.044	1.046
TLU	0.186	1.229

The degree of association between each discrete variable is also computed using contingency coefficient test, which has revealed that there is no problem of multi co linearity for each coefficient is very low (table 3).

Table 3: Contingency Coefficients for Discrete Explanatory Variables on Soil and Water Conservation Practices

	SLOPECAT	SERIOUS	PERCESWC	LSECURIT	PRONE
SLOPECAT	1				
SERIOUS	0.155	1			
PERCESWC	0.173	0.131	1		
LSECURIT	0.064	0.131	0.071	1	
PRONE	0.336	0.256	0.122	0.024	1

The maximum likelihood method of estimation is used to bring forth the parameter estimates of the binomial logistic regression model and statistically significant variables are identified in order to measure the relative importance on the farmers' soil and water conservation decision (table 4).

The likelihood ratio test statistics exceed the chi-square tabulated value with 11 degrees of freedom at less than 1 percent probability level. This indicates that the presupposed hypothesis, that all coefficients of the variables except intercept are equal to zero is rejected. The value of Pearson chi-square also indicated the goodness-of-fit for the fitted model.

Another measure of goodness-of-fit is based on a scheme that classifies the predicted value of the dependent variable, decision on practicing soil and water conservation as 1 if p (i) is greater than or equal to 0.5 and 0 otherwise. In what follows, the model correctly predicts 111 of 120 (92.5 percent) of observations. The sensitivity (correctly predicted technology users) and the specificity (correctly predicted non-technology users) of the logit model are 94.8 and 88.4 percent, respectively. Consequently, the model predicts groups, technology users and non-technology users fairly and accurately.

Table 4: The Maximum Likelihood Estimates of the Logit Model

	Estimated coefficients	Standard error	Odds ratio	Wald statistics	P-value
CONSTANT	-10.891	29.385	0.000	0.137	.711
EDULHH	-0.173	0.192	0.841	0.811	0.368
FEXPER	-0.096	0.033	0.909	8.529	0.003***
TLABOME	1.359	0.413	3.893	10.848	0.001***
FARMSH	1.344	1.346	3.835	.997	0.318
EAVISIT	0.478	0.131	1.613	13.396	0.000***
SERIOUS	1.944	0.906	6.986	4.606	0.032**
TLU	-0.086	0.239	0.918	0.130	0.718
PERCESWC	7.747	29.315	2314.132	0.070	0.792
LSECURIT	-2.426	1.572	0.088	2.381	0.123
PRONE	0.168	0.916	1.183	0.034	0.854
SLPOECAT	0.690	.975	1.993	0.500	0.480

Pearson Chi-square	108.070***
-2Log likelihood Ratio	48.519
Correctly predicted[a]	92.5
Sensititvity[b]	94.8
Specificity[c]	88.4

Note: * = significant at $p < 0.1$; ** = significant at $p < 0.05$; *** = significant at $p < 0.01$

Based on 50-50-probability classification scheme[a]

Correctly predicted adopters based on a 50-50-probability classification scheme[b]

Correctly predicted non-adopters based on a 50-50-probability classification scheme[c]

Discussion on Significant Explanatory Variables

The result of the model shows that the explanatory variables: the number of years the household was involved in farming (FEXPER), the total household labour in man equivalent (TLABME), extension agent visit (EAVISIT), farmers level of perception on soil erosion (SERIOUS) have statistically significant relationship with adoption of soil and water conservation practices by the farmers. On the other hand, the coefficients of the variables such as educational level of the household (EDULHH), the farm area which includes the cultivated and fallow land (FARMSH), the slope category of the farm (SLPOECAT), the total livestock unit (TLU), perception of soil and water conservation technologies on increasing productivity of the land (PERCESWC), land security or security of tenure (LSECURIT), and steep land prone to soil erosion (PRONE) are not significantly related at conventional level of probability. The results of the logit model estimates of statistically significant variables are interpreted below.

An increase in the number of years of the household's farm experience decreases the decision on practicing soil and water conservation practices, as the sign is consistent with prior expectation. Negative relation shows that a longer experience in farming, better knowledge, attitude and skill is developed on the operation and conduct of traditional agricultural activities and methods of production, which hinders acceptance of changes and adoption of new ideas and techniques. The odds ratio in favor of practicing soil and water conservation practices decreases by a factor of 0.909 for an increase in farm experience by one year. Younger farmers have a longer planning horizon and thus are more likely to invest in soil and water conservation. This finding is in accordance with findings of Tegegne (1999) that the effect of farmers' age can be taken as a composite of the effect of farming experience and planning horizon. The reason might be that a soil conservation technology is an investment, which needs time to generate benefits. The expectation of old persons' ability to reap this benefit is very low because of the fact that expected lifetime decreases with an increase in age. Therefore, old persons rather prefer to pay for technologies that result in short time returns. Moreover, most soil conservation technologies demand high labor payments, where as old age results in loss of own labor and command over others.

Farmers usually do not prioritize soil and water conservation practices, as they do not regard it as routine farm activities like crop production and livestock rearing. They only allocate their limited amount of labor for practicing soil and water conservation if there is extra labor beyond household consumption though the technology demands the maximum labor available as it is highly labor intensive with reference to construction of stone bund and cut off drain. The result is the same with a prior expectation both in significance and its positive relation that an increase in the total household labor in man equivalent encourages a decision on practicing soil and water conservation. As a result, other things held constant, the odds ratio in favor of decision on soil and water conservation practices increases by a factor of 3.893 for a unit increase of total household labor in man equivalent.

Extension agents' visit represents the frequency of visit to the farmers by the development agents per year. Increasing the number of visits made by the development agent has positive relation with soil and water conservation practices, which results from accelerated effective dissemination of soil and water conservation information to the farmers. Visits by the development agent such as village level training, village tours, information from mass media and participation in conservation planning enhance the level of investment in soil and water conservation significantly. Other things held constant, the odds ratio in favor of decision on soil and water conservation practices increases by a factor of 1.613 for a unit increase of frequency of visit by the development agent per year.

This finding is supported by the findings of a study on the economics of soil and water conservation that the degree of access the farmer has to information from agricultural experts, as has been expected, was found to influence the conservation decision positively. This is because the more agricultural advice a farmer gets and the more closely performances are observed; more farmers would be willing to construct new or maintain already built improved structures. Well-informed farmers are more likely to take rational decisions and have longer planning horizons (Wegayehu Bekele, 2003).

4.2. Extent of Adoption of Soil and Water Conservation Technologies

Stone bund/soil bund, cut off drain, inorganic fertilizer, manure, and crop residue are regarded as the important components of soil and water conservation technologies. Hence, the extent of use of prevailing practices in the study area was assessed. The coverage of technologies was taken as a proxy to the extent of their use. Coverage of technologies varies considerably in that 77 percent of the households use either stone bund or soil bund alone and 23 percent use stone bund with cutoff drain. The households who use all the technologies including inorganic fertilizer, manure, crop residue, stone bund, and cutoff drain represent 16 percent (table 5). Majority of the households, which represent 18 percent, use only manure and stone bund.

Table 5: Extent of Adoption of Soil and Water Conservation Measures

Type of Soil and Water Conservation Technologies	n	%
Inorganic fertilizer, manure, crop residue and stone bund	5	7
Inorganic fertilizer, manure, crop residue, stone bund and cutoff drain	12	16
Manure and stone bund	13	18
Manure, crop residue, and Stone bund	10	13
Miscellaneous	37	48
Total	77	100

5. Conclusion and Recommendations

This study emphasizes that understanding of socio economic, institutional, and bio-physical attributes of technologies that influence farmers' decision on practicing soil and water conservation is a necessary and first step to formulate sustainable land management programs. Among these, the following are salient issues that emanated from the study.

Extension services that enhance farmers' understanding on land degradation process play a crucial rule in the promotion of technologies related to SWC. This was indicated by significant differences between technology users and non-technology users compared in this study. Therefore, the extension system should intensify its endeavors in promoting sustainable agriculture with a due recognition of differences among farmers in their understanding of the soil degradation symptoms and access to extension contacts.

Farmers' access to productive resources such as labor differentiates their responses to external technologies and option of investment. This observation was confirmed by differences among farmers addressed in the study with respect to availability of labor at household level. Hence, technology design and dissemination should take into account such differential access to the resource among farmers.

Owing to differential costs and benefits to different agencies (state, local communities, and individuals) related to soil and water conservation practices, the interaction and relation among the national objectives, soil and water conservation objectives (technical), and farm household objectives, pose multiple trade-offs, which require multi location studies in the country. Therefore, further studies addressing these trade-offs are recommended for better planning of soil and water conservation extension, whereby a win-win situation would be achieved.

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