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Factors Influencing Adoption of Soil Conservation Measures in Southern Ethiopia: The Case of Gununo Area

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Abstract
Soil degradation is one of the most serious environmental problems in Ethiopia. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile lands and other factors attributed to population pressure. This study used a binomial logit model to identify factors that determine adoption of physical soil conservation measures, namely soil bunds and *fanyajuu* in Southern Ethiopia, Gununo area. Data collected from a random sample of 120 heads of households were used to estimate the binomial logit model. The results show that adoption of soil conservation measures depends on a host of factors. About 78 percent of the sample cases were correctly predicted using the model.

Keywords: adoption, binomial logit model; soil conservation measures, soil erosion

1 Introduction

Ethiopia is one of the largest countries in Africa both in terms of land area (1.1 million km^2) and population (70.7 million). With a per capita GNP of 100 dollars in 2001, Ethiopia is one of the poorest countries in the world (World Bank, 2003). The Ethiopian economy is based mainly on agriculture which provides employment for 85 percent of the labor force and accounts for a little over 50 percent of the GDP and about 90 percent of export revenue. However, low productivity characterizes Ethiopian agriculture. The low productivity of the agricultural sector has made it difficult to attain food self-sufficiency at a national level.

Natural resource degradation is the main environmental problem in Ethiopia. The degradation mainly manifests itself in terms of lands where the soil has either been eroded away and/or whose nutrients have been taken out to exhaustion without any replenishment, deforestation and depletion of ground and surface water. The majority of the farmers in rural areas of Ethiopia are subsistence-oriented, cultivating impoverished soils on sloppy and marginal lands that are generally highly susceptible to soil erosion and other degrading forces. Soil erosion is a phenomenon, which mainly occurs in the highlands of Ethiopia (areas $>$ 1500 meters above sea level) which constitute about 46 percent of the total area of the country, support more than 80 percent of the population,

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and account for over 95 percent of the regularly cultivated land and about 75 percent of the livestock population (SHIFERAW and HOLDEN, 1998). Erosion is most severe on cultivated lands, averaging 42 metric tons (MT) per hectare per year on currently cultivated lands and 70 MT per hectare per year on formerly cultivated degraded lands (HURNI, 1988). According to GIRMA (2001), Ethiopia loses annually 1.5 billion MT of topsoil from the highlands by erosion. This could have added about 1 to1.5 million MT of grain to the country's harvest. A study by SHIFERAW and HOLDEN (1998) shows that the problem of soil erosion is compounded by the fact that some farmers dismantled the conservation structures built in the past through food for work incentives. In fact, until the early 1990s farmers were not allowed to remove the conservation structures once built on their land. However, the introduction of economic reform program in 1990 and subsequent liberalization of the economy also brought more freedom and hence conservation structures could be removed if the land user so wishes.

A review of the relevant literature points to the fact that a number of empirical studies have been undertaken on technology adoption under Ethiopian context. However, nearly all of them have been addressing issues of adoption in relation to improved production technologies. Available evidence shows that studies on the determinants of adoption of soil conservation measures are few and far between. Therefore, this study was conducted in view of bridging this gap. The objectives of this paper are to identify socioeconomic, demographic, institutional and biophysical factors factors, which influence adoption of physical soil conservation measures in Gununo area (Southern highlands of Ethiopia). The rest of this paper is organized in three sections. Section II deals with the research design and methods of data collection and analysis. Section III discusses the findings of the study. The final section summarizes the findings and discusses their policy implications.

2 Research design and analytical method

2.1 Description of the study area

The study area, Gununo, is located in Kindo-Koysha district of Wolaita Zone, the Southern Nations, Nationalities and Peoples Regional State[3]. More specifically, it is located in Doge-Shakisho peasant association, which is found in the southern part of the Ethiopian highlands. The altitude of the study area ranges from 1980 to 2100 meters above sea level. The study area covers 1,006 hectares with an average population density of 523 persons per km^2. Agriculture is the principal economic activity in the study area, though some people derive additional income from basketry, pottery and local beverages. Agricultural production is destined mainly for home consumption. The principal agricultural activity is crop cultivation, which is entirely rain-fed with livestock

[3] With the change in government in 1991, on the basis of ethnic, linguistic and cultural identity, the country was divided into 9 semi-autonomous regional states, one federal capital (Addis Ababa) and one special administrative division (Dire Dawa). According to the Ethiopian Federal Democratic Republic administrative hierarchy, the regional states are divided into zones, districts and *kebeles* in urban areas or peasant associations in rural areas (local administration units), in that order.

rearing as a secondary activity. Almost every farmer practices two cropping systems on his/her cultivated land -a garden system and a field cropping system. In the gardens, farmers plant enset (a staple food of the area)[4], coffee and cabbage. Farmers plant on their fields seasonal crops, such as maize, haricot beans, sorghum, barley and teff (*Eragrostis tef*). Among root crops, sweet potato, Irish potato, taro, cassava and yam are important in the area.

Gununo area is characterized by unimodal rainfall regime with extended rainy season from March to October, although the other months have little to moderate amount of rainfall. Over the 1981-1987 period, the average annual rainfall was 1335 mm and the mean maximum temperature was about 23°C, while the minimum temperature ranged between 15°C and 18°C (SCRP, 1988). Undulating slopes divided by V-shaped valleys of seasonal and/or relatively permanent streams characterize the topography of the study area. Very steep slopes are found along the valley sides, where slopes greater than 30% are very common.

The data for this study were collected from six villages located in the Gununo area. The study covered a total area of 269 hectares with 329 households at the time of the survey (September 2000). The Gununo catchment, which consists of four villages namely Fatata, First Shega, Second Shega and Second Shakisho, was one of the seven national research stations of the Soil Conservation Research Program (SCRP). The SCRP was implemented jointly by the Ethiopian Ministry of Agriculture and the Center for Development and Environment of the University of Berne (Switzerland), in the period 1982-1993. In the course of its implementation, the SCRP introduced and popularized two types of physical soil conservation measures, namely soil bunds and *fanyajuu* in the Gununo area. These structures consist of narrow ridges and canals at slight angle to the contour in order to control erosion and facilitate terrace development. *Fanyajuu* is a terracing process whereby a trench is excavated to form an embarkment on the upper side by throwing the excavated soil uphill whereas soil bunds are constructed by digging a ditch and throwing the soil downhill.

As part of its strategy to popularize soil conservation measures in the Gununo area, the SCRP constructed, free of charge, soil bunds and/or *fanyajuu* on the fields of 220 households (first on the fields of 93 households located in the Gununo catchment and at a later stage on the fields of 127 households located in Buralessa and Gedalla villages, which are adjacent to the catchment) with the belief that these structures would have multiplier effects on the farmers in close proximity to the catchment by way of demonstration and as a result of social interaction. For the purpose of this study the Gununo area was divided into two sites: one with soil conservation structures constructed on farmers' fields by SCRP and another one where there was no direct intervention by SCRP. The former covers an area of 174 ha (74 ha in the Gununo catchment and 100 ha in villages adjacent to the catchment), while the latter covers an area of 95 ha (consisting of Second Shakisho and Second Shega villages located in the Gununo catchment).

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[4] Enset (*Ensete ventricosum*) is a banana-like perennial plant grown throughout the Southern Highlands of Ethiopia as the major staple food crop by many cultural groups

2.2 Sampling design

As already noted, the study area was divided in to two sites, one with soil conservation structures constructed on farmers' fields by SCRP (treated site[5]) and another one where there was no direct intervention by SCRP (non-treated site). The treated site consists of four villages, namely Fatata, First Shega, Buralessa and Gedalla while the non-treated site consists of two villages, namely Second Shakisho and Second Shega. In the early 1980s, soil bunds and *fanyajuu* were introduced in Fatata and First Shega villages. More precisely, the SCRP constructed the structures on the fields of the 93 households residing in the two villages. In 1987, following the request made by the farmers in Burallessa and Gedalla villages, the SCRP constructed soil bunds and fanyajuu on the fields of 127 households through the food-for-work scheme.

The survey covered 120 household heads (80 from the treated site and 40 from non-treated site) randomly selected from six villages stratified to include representative samples of areas with (four villages) and without (two villages) direct intervention from SCRP (Table 1). With regard to the sampling technique, proportional random sampling technique was used to select sample respondents from each village.

Table 1: Distribution of sample respondents by villages and farmer group

Site	*Village*	*Total number of households*	*Sampled households*					
			Adopters		*Non-adopters*		*Total*	
			N	*% of total sample*	*N*	*% of total sample*	*N*	*% of total sample*
Treated	Fatata	60	21	17.5	1	0.8	22	18.3
	1st Shega	33	6	5.0	6	5.0	12	10.0
	Buralessa	58	12	10.0	9	7.5	21	17.5
	Gedalla	69	12	10.0	13	10.8	25	20.8
Sub-total		220	51	42.5	29	24.2	80	66.6
Non-treated	2nd Shega	55	6	5.0	14	11.7	20	16.7
	2nd Shakisho	54	4	3.3	16	13.3	20	16.7
Sub-total		109	10	8.3	30	25.0	40	33.4
Grand Total		329	61	50.8	59	49.2	120	100

Although most of the adopters were from villages located in the treated site, there were adopters in villages located in the non-treated site. On the other hand, there were non-adopters even within villages located in the treated site[6]. It should be noted that of the 80 sample respondents selected from the treated site those farmers, who retained the

[5] A treated site is a site where SCP constructed soil conservation structures on farmers' fields.

[6] Adopters were defined as farmers who had either soil bunds or *fanyajuu* or both in at least one plot of their farms at the time of the survey.

introduced technology, either totally or partially, were considered as adopters; whereas those who removed the structures totally were considered as non-adopters. More precisely, of the 80 sample respondents selected from the treated site, 51 were considered as adopters (18 retained the soil conservation structures built on their fields and 33 removed the structures partially) and the remaining 29 farmers were considered as non-adopters (they removed all the structures built on their fields). Similarly, of the 40 sample respondents selected form the non-treated site, 10 adopted the physical soil conservation measures, while the remaining 30 did not adopt the measures.

2.3 Method of data collection

Field research was conducted from September to December 2000. A structured questionnaire was used for the field interviews. The questionnaire was pre-tested by administering it to selected respondents. On the basis of the results obtained from the pretest, necessary modifications were made on the questionnaire. Five technical assistants and two researchers administered the structured questionnaire. In addition to the questionnaire survey, discussions were made with key informants including community leaders, development workers and representatives of non-governmental organizations. Moreover, group discussions were made with randomly selected farmers. These informal techniques helped to acquire useful and detailed information, which would have been difficult to collect through the questionnaire survey.

2.4 Analytical approach

Farmers' decision to adopt or reject new technologies at any time is influenced by a complex set of socioeconomic, demographic, institutional and biophysical factors. Modeling farmers response to agricultural innovations has, therefore, become important both theoretically and empirically. Analysis of the relationship between adoption and determinants of adoption involves a mixed set of qualitative and quantitative data. The response (dependent) variable is dichotomous taking on two values, 1 if the event occurs and 0 if it does not. Estimation of this type of relationship requires the use of qualitative response models. In this regard, the linear probability models, logit and probit models are the possible alternatives. Both the logit and probit models yield similar parameter estimates and it is difficult to distinguish them statistically (ALDRICH and NELSON, 1990). However, MADDALA (1983) and GUJARATI (1988) reported that the logistic and cumulative normal functions are very close in the mid-range, but the logistic function has slightly heavier tails than the cumulative normal function; that is, the normal curve approaches the axes more quickly than the logistic curve. Because of the fact that the binomial logit model is easier to estimate and simpler to interpret, it is used in the present study.

2.5 Working hypotheses and variable specification

Farmers' decision to adopt new technologies at any time is influenced by the combined effect of socioeconomic, demographic, institutional and biophysical factors, which are related to their objectives and constraints. In this section, the variables to be used in the binomial logit model and the associated working hypotheses are presented.

The dichotomous dependent variable for the adoption model, CNSRV, indicates whether or not a household uses soil conservation measures. CNSRV=1, for households that had either soil bunds, or *fanyajuu* or both in at least one plot of their farms at the time of the survey (adopters) and CNSRV=0 for households that had no soil conservation structures on their fields at the time of the survey (non-adopters). The independent variables of the study are those which are hypothesized to have association with the dissemination and adoption of soil conservation measures. More specifically, the findings of various empirical studies on the adoption of soil conservation measures, the existing theoretical explanations, and the authors' knowledge of the farming systems of the study area were used to select 15 explanatory variables and structure the working hypotheses. The potential explanatory variables, which are hypothesized to influence the adoption of physical soil conservation measures in the study area are presented in Table 2.

3 Results and Discussion

In this section the results of the survey and analytical findings are presented and discussed.

3.1 Descriptive results

As noted earlier, a sample of 120 households consisting of 61 (51%) adopters and 59 (49%) non-adopters was selected from six villages located in Gununo Catchment. About 90 percent of the household heads were males. The survey results show that adopters and non-adopters differ in various aspects. On average, the adopters were relatively younger (42.4 years) than the non-adopters (43.1 years). The non-adopters had slightly larger family size (7.1 persons) than the adopters (6.8 persons). On average each household in the adopter group had 4.5 adult members (active agricultural workers in the age bracket of 15-65 years), while the corresponding figure for the non-adopter group was 3.8. Adopters of soil conservation measures had an average of 1.74 years of formal schooling. The corresponding figure for the non-adopters was 2.25 years. The average size of farmland owned by the sample respondents was 0.8 ha. Adopters owned, on average, relatively larger farm size (0.88 ha) than the non-adopters (0.73 ha). Furthermore, the adopters kept, on average, more livestock (1.8 TLU) than the non-adopters (1.6 TLU). The average land to man ratio for the sample respondents was found to be 0.11 (0.11 for the adopters and 0.12 for the non-adopters). This very low land to man ratio indicates that the area is overpopulated. Therefore, soil conservation technologies, which take some land out of production, like construction of soil conservation structures, have little chance of acceptance by farmers in the study area.

About 59 percent of the respondents reported that their farmlands were susceptible to erosion. Similarly, about 77 percent of the respondents perceived soil erosion as a problem. With regard to security of land ownership right, about 90 percent of the respondents indicated that they felt secure to use their farmland at least in their lifetime.

Table 2: Summary of the Variables used in the logistic regression model.

Explanatory variables	*Unit or type*	*Expected relationship*	*Empirical studies supporting the expected relationship*
AGEF	Age of the household head in years	negative	Gould *et al.* (1989); Sureshwaran *et al.* (1996); Yohannes (1992); Shiferaw and Holden (1998)
FAMILYSZ	The total number of members in a family.	negative	Shiferaw and Holden (1998)
ASSIST	Dummy, 1 if the farmer gets assistance from governmental or non-governmental organization to adopt soil conservation measures; 0 otherwise	positive	Ervin and Ervin (1982); Norris and Batie (1987); Sureshwaran *et al.* (1996); Pattanayak and Mercer (1998)
EDUC	Schooling years of the household head	positive	Ervin and Ervin (1982); Yohannes (1992); Pender and Kerr (1996); Sureshwaran *et al.* (1996)
FARMSZ	Total area of the farm land (cultivated, grazing, homestead and forest) in hectare.	positive/ negative	Ervin and Ervin (1982); Norris and Batie (1987); Gould *et al.* (1989); Sureshwaran *et al.* (1996); Shiferaw and Holden (1998); Mbaga-Semgalawe and Folmer (2000); Boserup (1965)
LANDSECU	Dummy, 1 if the farmer feels that the land belongs to him/her at least in his/her lifetime; 0 otherwise.	positive	Ervin and Ervin (1982); Norris and Batie (1987); Yohannes (1992); Girma (2001); Mulugeta *et al.* (2001)
LANMAN	The ratio of farm size to family size	negative	Shiferaw and Holden (1998); Lapar and Pandey (1999)
INDEPNDT	The number of economically active family members in the household	positive	Pender and Kerr (1996); Sureshwaran *et al.* (1996)
GROUP	Dummy, 1 if the household has a plot in the SCRP catchment; 0 if the household has its land in Buralessa and Gedalla villages.	positive	Mulugeta *et al.* (2001)
PERCEPTN	Dummy, 1 if erosion problem is perceived as a serious problem; 0 otherwise.	positive	Ervin and Ervin (1982); Shiferaw and Holden (1998)
SLOPE	Dummy, 1 if the farmland is steep or very steep; 0 otherwise.	positive	Ervin and Ervin (1982); Norris and Batie (1987); Gould *et al.* (1989); Pattanayak and Mercer (1998); Lapar and Pandey (1999)
TECHATTR	Dummy, for technology characteristics: 1 if farmers express physical soil conservation measures as a source of rodents, running grasses and pose difficulty in plowing; 0 otherwise.	negative	Yohannes (1992); Shiferaw and Holden (1998)
LIVSTOWN	Livestock holdings of the household head in Tropical Livestock Unit (TLU)*.	positive	Shiferaw and Holden (1998)
TYHOUSE	Dummy, 1 if the farmer has corrugated iron roof house; 0 otherwise.	positive	Shiferaw and Holden (1998); Mulugeta *et al.* (2001)
OFFINCOM	Dummy, 1 if the farmer earns off-farm income; 0 otherwise.	positive/ negative	Ervin and Ervin (1982); Clay *et al.* (1998); Mbaga-Semgalawe and Folmer (2000)

* One Tropical Livestock Unit (TLU) is equal to 250 kg which is equivalent to 1 camel; 0.7 cattle; 0.8 horse/mule; 0.5 donkey; 0.1 goat/sheep (ILCA, 1992).

This high percentage could be attributed to the fact that there was no land redistribution in the study area. The majority of the respondents (about 55%) reported that the physical soil conservation structures have inherent problems (the structures being considered as breeding ground for rodents, expansion of grass towards the farm land and posing difficulty in plowing across the field). Sixty-one percent of the respondents indicated that they earned additional income from non-farm activities. Eighteen percent of the sample respondents owned corrugated iron-roofed houses whereas the rest (82 %) owned thatched houses.

Farmers' decision to adopt soil conservation measures is not only influenced by their perception of erosion hazard but also by the types of structures and their attributes. As already noted, of the 80 sample respondents in the treated site, 33 removed the structures partially and 29 removed them totally. The sample respondents who removed the soil conservation structures partially or totally were asked to list down the reasons for their decision and their responses are set out in Table 3. About 55 percent of the sample farmers who removed soil conservation structures partially and about 59 percent of the respondents who removed the structures totally reported that mole rat, running grass and difficulty of plowing across the field were the main reasons for removing the soil conservation structures. Other important reasons for removing structures partially or totally include, the belief that the farmland was relatively flat, the potential loss of land to conservation structures, which occupy part of the scarce productive land, and proximity of the plot, from which the structures were removed, to *enset* field. This is because *enset* plant is believed to help control soil erosion.

Table 3: Distribution of sample farmers from the treated site by their reasons for removing soil conservation structures partially or totally

Reasons	*Removed partially*		*Removed totally*	
	N	*%*	*N*	*%*
Technology attributes[1]	18	54.5	17	58.6
Slope of the farm land was not steep	3	9.1	6	20.7
Shortage of the farm land and technology attributes	7	21.2	0	0
Shortage of land[2]	3	9.1	4	13.8
Plot not far from enset field	1	3.0	1	3.4
Shortage of land and moderate slope of the plot	1	3.0	0	0
Fear of conflicts with neighbors	0	0	1	3.4
Total	33	100	29	100

[1] structures were source of rodents and running grass and increased labor time for land preparation

[2] structures put considerable amount of land out of production

The survey results reveal also the reasons why the majority of the sample farmers in the non-treated site (75 percent) did not adopt physical soil conservation measures (Table 4). Responses from non-adopters in the non-treated site about the reasons for not adopting physical soil conservation measures indicate that loss of cultivable land to conservation structures was the most commonly cited major reason (about 27%) (Table 4). The inherent problems associated with the soil conservation structures, such as becoming sources of rodents and running grass and increasing labor time for land preparation were considered to be the major reasons for non-adoption by about 23 percent of the non-adopters in the non-treated site. Other reasons cited for not adopting physical soil conservation measures include, preference given to indigenous soil conservation measures (13.3%), the perception that soil erosion was not a problem because of the moderate slope of the farmland (10%), lack of government assistance (10%), labor shortage (10%) and relatively high labor requirements to establish and maintain the structures (7%)[7].

Table 4: Farmers' reasons for the non-adoption of physical soil conservation measures in the non-treated site

Reasons	*Number of farmers*	*Percent*
Structures take some land out of production	8	26.7
Structures are sources rodents, running grass and create difficulty in plowing	7	23.3
Prefer indigenous soil conservation measures	4	13.3
The slope of the farm land was not steep	3	10.0
Lack of government assistance	3	10.0
Labor shortage	3	10.0
High cost of labor for establishment and maintenance of structures	2	7.0
Total	30	100

3.2 Analytical findings

The maximum likelihood method of estimation was used to elicit the parameter estimates of the binomial logistic regression model and statistically significant variables were identified in order to measure their relative importance on the farmers' soil conservation

[7] The indigenous soil conservation practices that were reportedly used in the study area include planting of banana, *enset*, crop-residue/trash line, and construction of water-way.

adoption decision. The binomial logistic regression required six iterations to generate the parameter estimates[8].

The value of Pearson - χ^2 indicates the goodness-of-fit test for the fitted model. The likelihood ratio test statistic exceeds the χ^2 critical value with 15 degrees of freedom at less than 1 % probability level, indicating that the hypothesis that all the coefficients, except the intercept are equal to zero is rejected. Another measure of goodness of fit is based on a scheme that classifies the predicted value of the dependent variable, CNSRV, as 1 if $P_{(i)} \geq$ 0.5 and 0 otherwise. The model correctly predicts 94 of 120 (78.3 percent) observations. The sensitivity (correctly predicted adopters) and the specificity (correctly predicted non-adopters) of the binomial logit model are 78.7 percent and 78 percent, respectively. Thus, the model predicts both groups, the adopters and the non-adopters, fairly accurately.

The maximum likelihood estimates for the binomial logit model are set out in Table 5. The model results indicate that the signs of all the variables, except that of TECHATTR and TYHOUSE, turned out to be consistent with the a priori expectations. Out of the fifteen variables hypothesized to influence the adoption of physical soil conservation measures, four were found to be significant at less than one percent probability level. These include the number of economically active family members (INDEPNDT), whether or not a household has a plot within the SCRP catchment (GROUP), perception of soil erosion problem (PERCEPTN) and attributes of soil conservation structures (TECHATTR). Three variables were significant at five percent probability level. These variables include family size (FAMILYSZ), farm size (FARMSZ) and the type of house (TYHOUSE). Eight of the fifteen explanatory variables that were hypothesised to affect adoption of physical soil conservation measures did not have statistically significant effects.

The estimated binomial logit model shows that family size (FAMILYSZ) affects the adoption of physical soil conservation measures negatively and significantly. This result is consistent with the *a priori* expectation. This is so because households with larger family size are likely to face food shortage in periods of drought. As a result, they try to maximize short-term benefits and would be less interested in soil conservation measures whose benefits can be reaped in the long run.

As expected, farm size (FARMSZ) has a positive and significant influence on the farmers' decision to adopt physical soil conservation measures. The possible explanation is that larger farms are associated with greater wealth and increased availability of capital, which increase the probability of investment in soil conservation measures. Adoption of soil conservation measures is significantly and positively associated with the number of economically active family members (INDEPNDT). The implication is that house-

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[8] A technique called variance inflation factor (VIF) was used to measure the degree of linear relationships among the quantitative explanatory variables. Moreover, contingency coefficients were computed for each pair of qualitative variables to check for the degree of association among the qualitative variables. As the results show very small degree of collinearity among the explanatory variables, all of the qualitative and quantitative variables were included in the estimation of the model.

Table 5: The Maximum Likelihood Estimates of the binomial logit model.

Variable name	*Estimated Coefficient*	*Odds Ratio*	*Wald Statistics*	*Significance Level*
Constant	-5.173	0.01	8.014	0.005 ***
AGEF	-0.010	0.99	0.253	0.615
FAMILYSZ	-0.424	0.65	5.113	0.024 **
ASSIST	0.637	1.89	1.435	0.231
EDUC	-0.117	0.89	1.9322	0.165
FARMSZ	2.596	13.40	4.398	0.036 **
LANDSECU	0.729	2.07	0.804	0.37
LANMAN	-8.014	000	2.025	0.155
INDEPNDT	0.698	2.01	8.559	0.003 ***
GROUP	2.189	8.92	13.207	0.00 ***
PERCEPTN	1.927	6.87	8.458	0.004 ***
SLOPE	0.405	1.50	0.623	0.43
TECHATTR	1.465	4.33	8.799	0.003 ***
LIVSTOWN	0.001	1.00	1.027	0.311
TYHOUSE	-1.551	0.21	4.182	0.041 **
OFFINCOM	-0.057	0.95	0.013	0.910
Pearson-χ^2		55.065 ***		
Likelihood Ratio Test		117.114 ***		
Correctly Predicted		78.3[a]		
Sensitivity		78.7[b]		
Specificity		78.0[c]		

*** Significant at less than 1% probability level;

** Significant at 5% probability level

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

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

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

Source: model output

holds with large number of active agricultural workers are more likely to invest in soil conservation measures, which are known to be labor intensive. The variable GROUP, which indicates whether or not a household has a plot within the SCRP catchment, has a significant positive influence on the adoption of physical soil conservation measures.

This is precisely because those farmers who have plots with in the SCRP catchment have the possibility to meet the project staff and be well informed about the consequences of soil erosion than those who own land outside the catchment. As anticipated, farmers' perception of soil erosion problem (PERCEPTN) affects the adoption of soil conservation measures positively and significantly. The implication is that farmers who feel that their farmlands are prone to soil erosion are more likely to adopt physical soil conservation measures than those who do not perceive the problem of soil erosion.

The estimated model shows that the technology characteristics (TECHATTR) has a positive and significant influence on the adoption of physical soil conservation measures. The possible explanation may be that despite the perceived negative impacts associated with the technology, farmers adopt physical soil conservation measures. This could be explained by the fact that those farmers who had already adopted physical soil conservation measures were aware of the possible consequences of soil erosion and they retained the structures no matter how problematic they might be. It is, however, important that soil conservation technologies go hand in hand with appropriate technologies, which help mitigate the undesirable effects of the technologies in question. Contrary to the *a priori* expectation, the type of house, used as a proxy for wealth, has a significant negative influence on the adoption of physical soil conservation measures. This may be due to the fact that this variable is not a very good proxy for wealth. In fact, the informal survey results reveal that some farmers who own corrugated iron roofed houses had totally removed the soil conservation structures built by the SCRP. Similarly, some of the farmers who own corrugated iron roofed houses were categorized under the poor wealth category by the key informants, indicating that the possession of a corrugated iron roofed house is not a good indicator of the current wealth status in the study area. It is also interesting to note that, of the 22 respondents who owned corrugated iron roofed houses, thirteen reported that they received remittance from their children who settled in big urban centers and/or abroad, which in our view might make them less interested in soil conservation work.

4 Conclusion

This study attempted to identify important factors, which influence adoption of physical soil conservation measures in the Southern Highlands of Ethiopia, Gununo area. The empirical results show that the major factors influencing adoption of physical soil conservation measures in the study area are: farmers' 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 farmland (whether or not the farmer has a plot of land inside the SCRP catchment). An important implication of the results presented in this paper is that any intervention in soil conservation should recognize the heterogeneity in household characteristics, land holding, institutional patterns and technology-specific traits.

Another implication of the findings of this study is the need to increase farmers' perception of soil erosion problem through the provision of knowledge and demonstration of gains and risk reduction characteristics of soil conservation practices. This is important because the extent to which farmers understand and feel the need for controlling soil erosion affects adoption of soil conservation measures positively. The results also highlight the need to undertake research on indigenous soil conservation measures, which were reported to be well adapted to the study area by some of the non-adopters. It goes without saying that sustainable use of soil conservation measures critically depends on their suitability to the local ecology and the farming systems. Therefore, it is important to design soil conservation practices, which couple modern scientific knowledge with indigenous technical knowledge to facilitate their dissemination and ensure their sustainability.

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