Caraka Tani
Journal of Sustainable Agriculture
ISSN 2613-9456 (Print) 2599-2570 (Online)

Caraka Tani: Journal of Sustainable Agriculture, 37(2), 385-405, 2022
URL: https://jurnal.uns.ac.id/carakatani/article/view/60720
DOI: http://dx.doi.org/10.20961/carakatani.v37i2.60720

Factors Influencing Smallholder Farmers' Decision to Abandon Introduced Sustainable Land Management Technologies in Central Ethiopia

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Abstract

The Ethiopian government has made efforts to rehabilitate degraded lands using a range of sustainable land management (SLM) initiatives. One of the key components was the use of improved structural soil and water conservation (SWC) technologies. However, the effectiveness of technology adoption varies greatly among households and abandoning previously accepted measures is a typical occurrence. Thus, this study sought to discover factors influencing smallholder farmers' decisions to abandon already accepted SWC measures. The analysis was conducted based on data collected from 525 sample households surveyed in two districts in Central Ethiopia. An ordered cumulative logistic (POM) regression model was used to examine variables explaining households' decision behavior. The study findings have revealed that sampled households were at different adoption stages, i.e., dis-adopters (22%), pilot-level adopters (14%) and adopters (64%). The results from the POM model also show that a range of variables influenced farmers' dis-adoption decisions. Factors such as awareness about the risks of land degradation, access to training, incentives, land fragmentation, gender, full-time labor size, gentle slope plots, economic returns on investment and post-adoption follow-up were found to substantially influence smallholder farmers' adoption discontinuance decisions. Thus, policymakers should consider these variables in designing strategies to overcome barriers to SLM practices.

Keywords: dis-adoption; farmers; households; ordinal logistic regression; SWC measures

Cite this as: Alemu, T., Tolossa, D., Senbeta, F., & Zeleke, T. (2022). Factors Influencing Smallholder Farmers' Decision to Abandon Introduced Sustainable Land Management Technologies in Central Ethiopia. *Caraka Tani: Journal of Sustainable Agriculture, 37*(2), 385-405. doi: http://dx.doi.org/10.20961/carakatani.v37i2.60720

INTRODUCTION

Land resource degradation is one of the most prominent environmental and socioeconomic issues that humans face today (Tesfaye et al., 2014; Asfaw and Neka, 2017). The rate of degradation has been severely accelerated in the last fifty years due to anthropogenic activities (Tesfahunegn et al., 2021). At the global level, nearly 40% of arable land has been washed-out due to soil erosion and continues to be lost at the rate of 5 to 10 million ha annually (Asfaw and Neka, 2017; Limani, 2018; Lemma et al., 2022). Among others, Sub-Saharan Africa is one of the world's most eroded regions, with nearly 65% of its agricultural land affected in the past decades (Belay and Bewket, 2013). In Ethiopia, as it is another state in the region, damage to croplands due to soil erosion is a common incidence (Moges and Bhat, 2020;

* *Received for publication April 13, 2022*
Accepted after corrections August 12, 2022

Debie, 2021; Lemma et al., 2022). It will remain a serious challenge to subsistence agriculture, which is the backbone of the country's economy (Wordofa et al., 2020). Despite varying estimates of the extent of erosion, various studies have illustrated the severity of the problem. About half of the total land area (Amsalu and de Graaff, 2007; Tesfaye et al., 2022) and 66% of the cultivated land areas have been degraded, 25% of which was extremely and 4% was seriously eroded beyond what can be recovered (Asfaw and Neka, 2017). Studies conducted in some parts of Central Ethiopia, where the study area is found, by Mengesha and Denoboba (2015) and Lemma et al. (2022), show soil erosion as one of the reasons causing land degradation. Deforestation, agricultural expansion, overgrazing and continuous cultivation coupled with the steep slope nature of the cultivated land area aggravated soil erosion problems in the study area (Mengesha and Denoboba, 2015; Biratu et al., 2022; Goba et al., 2022).

To address the problems, the Ethiopian government employed a range of sustainable land management (SLM) measures since the 1970s (Limani, 2018; Ewunetu et al., 2021). In recent decades, participatory watershed management has been recognized at the national level under the framework of the national development strategy (Agidew and Singh, 2018). This framework triggered the launching of SLM programs along with other initiatives in selected areas of the country in 2009. The first phase of the project started in 2009 and was completed in 2013, while the second phase began in 2014 and ended in 2019. One of the program's key project components was the rehabilitation of degraded lands using structural soil and water conservation (SWC) technologies such as terracing, stone-bound, soil-bound, cut-off drains and area closures (Schmidt and Tadesse, 2019; Sileshi et al., 2019). The World Bank and other development partners contributed to the program's financing and implementation. Furthermore, the government instituted a national SWC construction campaign in 2011 to mobilize the community to build the necessary structures following watershed development principles (Mekuriaw et al., 2018).

Despite such a concerted effort, the trend hitherto indicates that the projects have had limited success in addressing the problem (Lemma et al., 2022). Several studies conducted in highland parts of the country have shown that land degradation remains a serious problem and the effectiveness of the SWC adoption measures is generally low (Debie, 2021; Tolassa and Jara, 2021). The evidence further revealed that, in some cases, discontinuing or abandoning the use of earlier adopted technologies are common (Miheretu and Yimer, 2017; Agidew and Singh, 2018). Smallholder farmers are not also making adequate maintenance investments to sustain the benefits (de Graaff et al., 2008; Schmidt and Tadesse, 2019; Debie et al., 2022). As a result, the degradation of farmland has not been reduced to acceptable levels and it has remained one of the pertinent issues to be tackled to ensure economic growth and development (Mengistu and Assefa, 2019).

Given the prevalence of SWC technology dis-adoption, researchers have paid far less attention to it than the numerous adoption studies available (Das and Rahman, 2018). Most previous adoption studies (Mekuriaw and Hurni, 2015; Asfaw and Neka, 2017; Sileshi et al., 2019; Tolassa and Jara, 2021) focused on identifying factors affecting households' decision to accept or reject verity of new SLM technologies. Most of these studies have looked at the adoption decision in dichotomous terms: adoption and no-adoption. Consequently, investigations were made often by using a binary "innovation-decision" model and did not take into account the various decision sequences that adopters pass through. Adoption decisions are a multistage process undertaken most often sequentially as, no-adoption, pilot-level adoption (exposure), adoption and continuous use or dis-adoption (Teshome et al., 2016; Ng, 2020). Even those few studies conducted on post-adoption behavior of households in Ethiopia by Amsalu and de Graaff (2007); de Graaff et al. (2008); Teshome et al. (2016) have not sufficiently analyzed the level and the reason farmers gradually abandon the innovation after having previously tried it. Understanding the rate of discontinuance and contributing factors are as important as determining the level of sustainable adoption for devising workable policies and strategies (Kumar et al., 2019). Furthermore, adoption efforts will not achieve the purpose of ensuring food security and reducing poverty unless barriers to sustainable adaptation are overcome (Bagdi et al., 2015).

This study sought to contribute to three knowledge gaps identified in previous studies. First, the analysis focused on the dis-adoption decision behaviors of households using areas supposed to represent a variety of socio-economic and agroecological contexts. The prior adoption studies overlooked innovation post-adoption behavior, converging on initial adoption (Ng, 2020). In this paper, dis-adoption refers to the gradual abandonment of previously implemented measures, from a full or initial level of adoption to a no-adoption situation (Huria et al., 2019; Soliman and Rinta-Kahila, 2020). Second, to frame the analytical model, the study conceptually looks into dis-adoption as a multi-stage decision-making process. According to Teshome et al. (2016) and Ng (2020), adoption-discontinuance may not be a one-time complete abandonment but may involve a period of various levels of engagement and disengagement. This extends the adoption theory frontiers through examinations of households' post-adoption decision sequences and provides another dimension for the investigation of SWC research. Third, the study explored the reason why households dis-adopt already accepted SWC measures while other remains on the initial level and full level of adoption. This helps policymakers to design workable strategies to overcome adoption discontinuance and enhance SLM efforts.

Thus, this study examined the determinants of smallholder farmers' dis-adoption of SLM practices with special emphasis on SWC measures in Central Ethiopia using an ordinal regression model based on Rogers' adoption discontinuance theoretical framework. According to Rogers et al. (2014), an adoption decision is a multistage process undertaken most often sequentially involving knowledge, persuasion, decision, implementation and confirmation (Ng, 2020; Soliman and Rinta-Kahila, 2020). In contrast to others, the last two stages are related to post-adoption decision behaviors. The implementation stages refer to the initial trial period for the new technology where individuals use the innovations and examine the outcomes. During the confirmation stage, adopters decide to continue or discontinue their adoption (Frei-Landau et al., 2022). Rogers et al. (2014) described two types of dis-adoption: replacement discontinuance and disenchantment discontinuance. The former deals with rejecting an innovation to adopt better alternatives, while the latter, which is the focus of this study, is abandoning measures as a result of dissatisfaction related to performance. Roger suggested discontinuance occurs at each stage in the adoption process. Huria et al. (2019) and Singh et al. (2020) advocated that abandoning a technology can occur shortly after a trial period (acceptance-rejection thesis) or after an extended period of continued use (adoption-rejection anomaly). This implies that a farmer may discontinue the introduced SWC measures either from trial/acceptance or full adoption stages. Thus, the dis-adoption process could take the following meaningful order: adoption, acceptance/initial adoption and dis-adoption.

MATERIALS AND METHOD

Description of the study area

This study was carried out in two designated districts in Central Ethiopia, namely Kewet and Sebeta-Hawas, among others. Kewet District is in the Amhara Region's northern Shoa Zone, whereas Sebeta-Hawas is in the Oromiya Region's southwestern Shoa Zone (Figure 1). These are some of the areas that were chosen to be addressed in the first phase of the SLM program carried out between 2009 and 2013. The Ethiopian government, in collaboration with the World Bank and other development partners, implemented SWC technology as a pilot project in these areas. They also have different agroecological zones than the other Central regions of the country participating in the program. Kewet, for example, is a lowland, semi-arid and low-potential area (Mekuriaw et al., 2018), whereas Sebeta-Hawas is a midland, highland and high-potential area. Furthermore, because most studies tended to focus on the country's northern highlands, these areas went unnoticed by most researchers for scientific analysis (Masha et al., 2021). Because of their differences, the two study areas can be considered representative of Central Ethiopia.

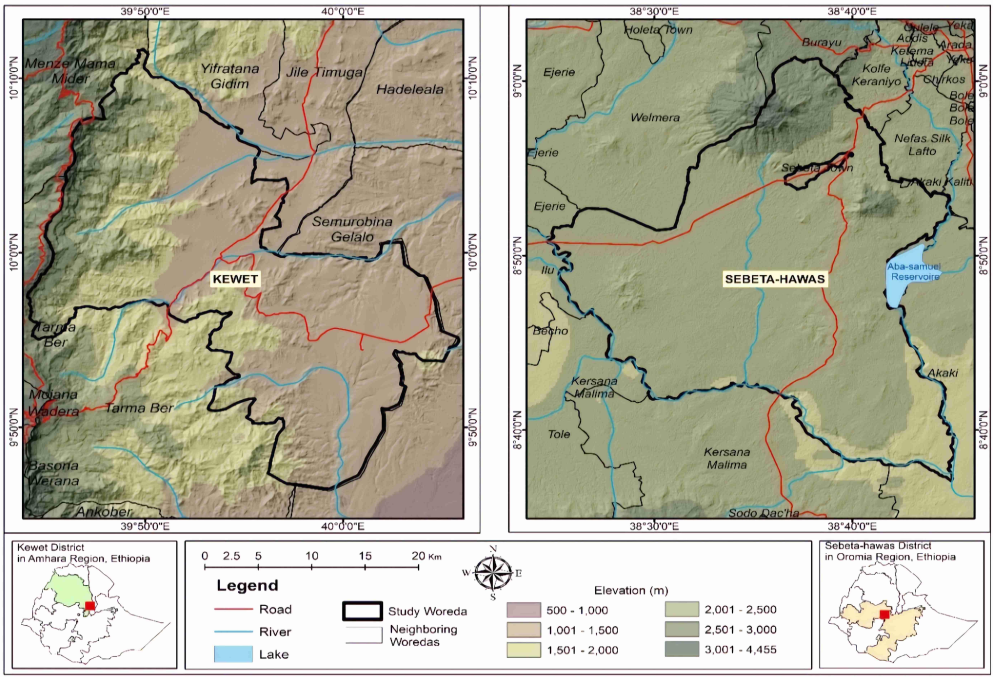

Figure 1. Map of the study area

Kewet District

One of the two study areas chosen for this study is the Kewet District, which is located 225 km north of Addis Ababa (Figure 1). The main study area was the Robit watershed located within the districts that include five peasant associations (kebeles), namely Ayaber, Alolo, Mengist, Debir and Abomsana. The peasant associations (kebeles) were those which were included in the first phases of the SLM program. This research area is located at an elevation range of between 1,001 to 2,500 m above sea level on average. The location extends from 9°50’0” N to 10°10’0” N latitude and 39°50’0” E to 40°0’0” E longitude. The average annual rainfall is 600 to 700 mm, with temperatures ranging from 17°C to 31°C (Gessesse et al., 2016). The vast majority of people in this region are rural smallholders who rely on arable land cultivation for a living. Based Ethiopian Statistics Service (ESS) estimation in 2022, the district has a total population of 160,500, of whom 82,700 were men and 77,800 were women (ESS, 2021). The area's dominant crops are sorghum, teff, maize, wheat and beans. Soil erosion was severely threatening agricultural production in the district. Various SWC measures have been implemented as part of a SLM program in this area since 2009.

Sebeta-Hawas District

Sebeta-Hawas is also one of the other districts identified for this study. It is 45 km away from Addis Ababa, in the southwestern part of the country. The main study area was the Atebela watershed located within the districts that include six peasant associations (kebeles), namely Haro Jila, Bole, Mogle, Korke, Koche and Jamo. The selected peasant associations (kebeles) are those that were identified for intervention in the first phase of the SLM program. This study site is a highland and humid area with an altitude range of 2,001 to 4,455 m above sea level and located between 8°40'0" N to 9°0'0" N latitude and 38°30'0" E to 38°40'0" E longitude, respectively (Belay and Assefa, 2021). The land feature of Sebeta-Hawas is characterized by mountains, hills and marshy plains and is surrounded by an “Awash” watershed in the west. The average annual rainfall varies between 1,000 and 1,200 mm. The area lies in the temperate climatic zone, with a temperature range of 12°C to 24°C. Based on ESS projection, the total population of the district was 189,912 of whom 97,150 were men and 92,762 were women (ESS, 2021). Wheat, teff, barley and beans are the dominant crops grown in the area. The agricultural systems in these watersheds are small-scale subsistence crop-livestock mixed farming systems. Soil erosion and soil nutrient depletion were severely threatening agricultural production in the district. Various SWC measures have been implemented as part of a SLM program in this area since 2009.

Data sources and methods

The data were mainly gathered from primary and secondary sources. Primary data were collected from farm-households, development agents and district-level SLM program focal persons through a survey conducted between November 2019 and January 2020. The secondary data employed were obtained from district-level agricultural offices' annual plans and reports. These sources were used to identify the number and location of target respondents. Primary data were collected from respondents by using a set of standardized closed and open-ended questionnaires and semi-structured interviews. Before the main questionnaire survey was distributed, a pilot pre-test was conducted on a randomly selected group of 12 non-sampled respondents. Various studies recommended a sample size of 10 to 50 units. To save time, cost and energy, this study used the 12 minimum subjects suggested by Julious (2005). Modifications have been made following the pilot survey. Then, enumerators who had been working as development agents were selected to carry out the survey. The first author of this paper was in the field throughout the data collection periods to supervise enumerators, conduct interviews and oversee the overall data gathering process. Semi-structured interviews have also been conducted to collect information from extension workers and district-level SLM project focal persons.

Sample size and sampling techniques

The target population of this study was farmers that participated in the first phase of the SLM program, initiated by the Ethiopian government in collaboration with the World Bank. More specifically, those who adopted improved SWC practices on their farmland between 2009 and 2013, both in Kewet and Sebeta-Hawas Districts, were considered. The total population size was estimated to be 1,557, of which 665 of them were from Sebeta-Hawas, while 892 were from the Kewet District. Then, the total sample size representing the population of the study was determined to be 525 units (276 from the Robit watershed and 249 from the Atabala watershed). The study applied a simplified formula applied by Yamane (1967) and recently used by various researchers, including Byamukama et al. (2019), Wordofa et al. (2020), Tolassa and Jara (2021) and Nkonki-Mandleni et al. (2022) to determine the required sample. Accordingly, for a larger population whose size is known, sample size can be determined using the formula $n = N/1+N (e^2)$, where n = sample size, N = population size and e = the margin of error. Assume that n_1 is the sample size from Sebeta-Hawas and n_2 is from the Kewet study population. Then, at a 5% significance level, $n1 = 665/1+ 665 (0.05)^2$ is proximately equal to 249 units and $n_2 = 892/1+ 892 (0.05)^2$ is equal to 276. Accordingly, the total sample size has been increased to 525 (n1 + n2). The required number of samples was taken from the total population by using the random sampling technique. First, agricultural offices in the respective districts (Sebeta-Hawas and Kewet) were contacted to identify kebeles found in each watershed area where the project was implemented. Then, local development agents supplied lists of those households that adopted SWC measures in the first phases of the project on their farm plots.

Analytical model specification

Definition of variables

The objective of this study was to examine factors influencing farmers' decision to dis-adopt the introduced SWC measures. Thus, the dependent variable was the dis-adoption status of households measured by farmers' adoption decision sequences as adoption, acceptance/pilot-level adoption and dis-adoption. According to Amsalu and de Graaff (2007) and Ng (2020) farmers pass through a series of intertwined adoption decision stages before abandoning the introduced SWC measures. Here, the variable of interest was to investigate why farmers "abandon" the use of introduced SWC measured relative to full adopters and the initial level of adopters. Adoption occurs when farmers maintain the existing structures and decide to replicate them on more than 26% of their farm plots. Those who expended considerable energy on implementing SWC measures were included because either they were convinced or incentivized. Acceptance occurs when households first receive the SWC measures as a result of project intervention; apply them up to 25% of their farm plots without expanding them to other farm plots. Dis-adoption occurs when farmers gradually abandon previously introduced measures either from acceptance or full adoption stages (Teshome et al., 2016).

Table 1. Description of explanatory variables

	Variables	Variable description
Demographic factors	Sex	Sex of the household head; 1 if male, 0 otherwise
	Age	Age of the household head in years
	Grade	Household head's highest grade completed in years
	Family size	Number of people living in the household
	Full-time labor size	Number of persons working full-time in agriculture
Institutional factors	Tenure security	Feeling of tenure security; 1 if feeling secure, 0 otherwise
	Training	Training in SWC measures; 1 if the household received training, 0 otherwise
	Assistance	Availability assistance program for SWC measures in the area; 1 if available, 0 otherwise
	Access to DAs	Contacts with development agents; 1 if yes, 0 otherwise
	Credit access	Access to credit services; 1 if yes, 0 otherwise
Social factors	Social group	Membership to local institutions; 1 if a farmer is a member and 0 otherwise
	Erosion problem recognition	Farmer‘s recognition of soil erosion as a problem; 1 if perceived, 0 otherwise
	SWC profitability	Farmer‘s attitude on the profitability of SWC; 1 if profitability is perceived, 0 otherwise
	Labor sharing	Farmer‘s participation in labor sharing activities; 1 if participated, 0 otherwise
Economic factors	Access to market	Distance to the nearest market area per kilometer
	Access to road	Distance to the nearest all-weather roads per kilometer
	Off-farm work	Farmer‘s engagement on off-farm activities; 1 if yes, 0 otherwise
	Income from crop	The total amount of annual income received in ETB
	Farming tools	Number of farming tools available
	Livestock income	Annual income received from livestock sources in ETB
	Livestock holding	Number of livestock measured by Tropical Livestock Units (TLU)
Plot related factors	Farm size	Total cultivated land size per hectare
	SWC treated land	SWC treated farm size per hectare
	Land fragmentation	The number of plots divided by total farmland size/hectare
	Land productivity	Total crop yield in quintal divided by land size/hectare
	Gentle slope	Gentle slope; 1 if the average slop plots are gentle, 0 otherwise
	High fertility	High level of soil fertility; 1 if the average soil fertility of plots is high, 0 otherwise
	Low flood risk	Low flood risk; 1 if the average flood risk of plots is high, 0 otherwise
	Distance to plots	Average distance in kilometers from a residential area to farmlands

The predictors were grouped into five blocks of factors such as demographic, institutional, economic, social and biophysical variables (Table 1). The demographic predictors were measured using five subscales: the household head's age, sex education, family size, number of full-time family laborers and farming experience. Institutional variables consisted of five indicators such as agricultural tenure security, extension service, credit availability, training support on SWC and availability of incentives. Economic factors were measured using eight indicators, such as market access, all-weather road access, farm income, off-farm income, livestock income, livestock ownership and farming tools. Four indicators were used to assess social predictors, including household perceptions of soil erosion, attitudes toward the benefits of SWC, social networks and participation in joint SWC activities. Finally, biophysical variables were estimated by using eight subscales: land size, land productivity; land fragmentation, family size to land ratio, average plot slope, land quality, flood risks and average distances to plots.

Model specification

This study employed an ordered logistic regression (logit) model. This model is used to estimate the association between a set of continuous or categorical predictors and a meaningfully ordered multi-category outcome variable (Hosmer and Lemeshow, 2000; Tabachnick and Fidell, 2007). Among many families of ordered logit models, this study used the most well-known and most frequently used model in practice, termed the cumulative logit or proportional odds model (POM). POM is used to estimate the probability of being at or below a specific outcome level for a response variable given a collection of explanatory variables (Agresti, 2007). Each predictor's effect is assumed to be the same across all categories of the ordinal dependent variable. In other words, the regression line generated by the model must be parallel, with the same regression coefficient but different intercepts. This constraint is known as the proportional odds assumption or the parallel lines assumption (Liu, 2009). Given that, the logit form of the ordinal logistic regression model for this study is expressed as follows: Let "Y" be an observed dependent variable that shows different adoption categories for the adoption abandonment model coded as in Equation 1.

$$Y = \begin{cases} \text{Adoption} = 1 \\ \text{Acceptance} = 2 \\ \text{Dis-adoption} = 3 \end{cases} \quad (1)$$

Let Y* be a latent unobserved variable that is continuous and not measured but has various threshold points. Then, the ordinal variable "Y" is a function of another latent variable, "Y*". It means the value of the observed ordinal variable "Y" is determined by whether or not "Y*" crossed a particular threshold, as shown by the following formula in Equation 2.

$$\begin{bmatrix} Y = 1 \ \text{if} \ -\infty \leq Y^* < \alpha 1 \\ Y = 2 \ \text{if} \ \alpha 1 \leq Y^* < \alpha 2 \end{bmatrix} \quad (2)$$

Where "Y" denotes an unobserved continuous variable and α1, α2 denote cut-points or thresholds in the distribution of Y. Here, there is no "Y = 3" for the last category because, in the cumulative distribution, the probability of the last category is 1 (100%). But, it is used as a reference to compare the probabilities of other categories. Since "Y*" is a latent variable, standard regression techniques are not applicable to directly estimate the outcome variable. Then, the relation between latent variable "Y*" and observable variable "Y" is obtained from the ordered cumulative probability function as presented in Equation 3.

$$\text{Log odd } (P(Y \leq J|xi) = \ln\left(\frac{P(Y \leq J|xi}{P(Y > J|xi}\right) = \alpha - (\beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4..\ \beta nxp\ldots \quad (3)$$

P(Y≤J|xi) is the probability of log odds of being at or below category "J", where J = 1 and 2 categories (adoption and acceptance). "xi" denotes set of predictors, where I = 1, 2, 3…. p and "α "are the cut points or intercepts and "β1, β2… βn" are logit coefficients.

Alternatively, the same functional relationship can be expressed by taking the antilog function of Equations 3 to obtain a direct estimate of the probabilities of adoption categories P (Y≤J|Xi). Direct estimation of the odds ratio from a given logit function can be expressed Equation 4.

$$\text{Odd ratio } (P(Y \leq J|xi) = \frac{P(Y \leq J|xi}{P(Y > J|xi} = e\ \alpha - (\beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4..\ \beta nxp\ldots (4)$$

Where P(Y≤J|xi) is the odd ratio of each dependent categorical variable, "e" anti-log function, β1, β2, β3…βn are logit coefficients and x1, x2, x3…xn are explanatory variables.

RESULTS AND DISCUSSION

This study sought to investigate factors influencing farmers' SLM technology abandonment/dis-adoption decisions by considering improved physical SWC technologies applied to on-farm plots. To that end, those farmers in the selected study area, who implemented one or more improved SWC measures, were surveyed. The measures were soil-bound, stone-bound, bench terraces and cut-off drains, which were mostly, applied in the study areas. For two very important reasons, all these clusters of technologies are considered instead of just one. First, in most cases, a particular technology is selected based on material availability and the conditions of the resources on the ground. For example, in areas where the stone is available, stone-bound is used. Where there are no stones, it is soil-bound. Thus, there is a possibility for a single farmer to use more than one measure depending on the situation at hand or in a single plot. In other words, adoptions of technology are not mutually exclusive or independent of each other (Amare et al., 2014; Mengistu and Assefa, 2019). Second, there are complementarities among SWC measures as far as factors affecting adoption statuses are concerned (Sileshi et al., 2019; Ewunetu et al., 2021). The sections that follow present the results and discussions made based on cross-sectional household survey data.

Households' attributes

A variety of explanatory variables were considered in this study, despite the fact that their application in the adoption literature is not always consistent. Variables were classified into five categories based on their levels of effects and ease of presentation, as can be read in Table 2: demographics, social, institutional, economic and farmland characteristics.

Demographic factors

Household head's sex, age, family size, highest grades completed and farm labor are the most widely used variables among adoption studies. Accordingly, results from the pooled sample reveal that male-headed households constituted 88%, while females made up the remaining 12%. Regarding the adoption categories, there was a significant variation in terms of household head's sex, age, family size and full-time family labor, at a 1% significance level. The proportion of male household heads in the adoption is slightly higher than in the acceptance and dis-adoption levels. This shows that female-headed households are significantly fewer than male-headed households for each adoption category. However, there were a higher proportion of female-headed households in the dis-adopters group compared to other groups (Table 2). This difference can be attributed to the fact that male-headed households have higher access to necessary resources and agricultural information increases their chances of adopting and continuously using new agricultural technologies (Asfaw and Neka, 2017). The circumstances are more or less similarly comparable in the disaggregated samples of the Sebeta-Hawas and Kewet Districts. This somehow implies that female-headed households are more likely to be dis-adopter than their male counterparts. The average age of the household head is likely to be fluctuating as the adoption intensity is mounting upward to the adoption stages. It seems that older households are more probably dis-adopters.

The average family size also differs significantly in both the entire and individual samples as it descends from higher to lower adoption stages, but with general diminishing patterns. Similarly, the mean numbers of full-time agricultural laborers substantially vary and sharply decrease along with adoption sequences in the pooled data. Households with a larger size have more human capital in terms of labor, so they are more likely to maintain and employ SWC policies consistently. The practices of SWC were more prevalent in households with a larger size (Atnafe et al., 2015; Limani, 2018; Belachew et al., 2020). By implication, it is expected that smaller sizes contribute to the gradual removal of existing structures. Finally, there appears to be no significant variation across adoption stages in terms of the household head's education, measured by the highest grade completed. This shows that the effect of this factor on the household's dis-adoption decision is more likely to be neutral as it is similar across adopters' groups.

Institutional factors

The most widely used institutional variables in adoption literature are land tenure security, credit service, access to extension agents (DA), training and financial/material incentives attached to SWC projects. The findings presented in Table 2 show that among the farm households in the sample, 88% had the feeling of tenure security, 91% received different kinds of training on the benefits and applications of SWC technologies and some 64% obtained different types of assistance from the government and non-governmental organizations. The different types of incentives provided are tools used for the construction of SWC structures, improved crop seed, fertilizer, improved animal breeds and finance. Similarly, nearly 94% and 47% of households had access to extension agents and received credit from formal credit sources for farm input purchases. The results further reveal significant adoption intergroup disparities in most institutional variables except access to DA. Both in combined and individual samples, the share of households who perceive that they have ownership rights (tenure security) to the plot they own is higher for actual, lower for pilot-level and medium for dis-adopters. Nonetheless, the value of this variable tends to diminish as one moves from higher to lower adoption segments. This implies that dis-adoption is linked, somehow, to a lack of tenure security.

Similarly, both in the pooled and the disaggregated data, the proportions of households that had training experiences on SWC technology applications consistently vary along with adoption classes, whereas assistance received and the availability of credit services tend to fluctuate. Government, non-governmental organizations and extension agents provided training in the study areas. Aside from that, additional communication channels were established with the goal of pushing the community to efficiently execute SWC activities. On the contrary, there are no substantial differences in terms of contact with development agents. According to qualitative data collected from officials and development agents, a higher number of households have access to development agents since each peasant association (locally known as "kebeles") has 2 to 4 professionals assigned to provide technical assistance to the rural farmers. This suggests that adoption status among adopters may not be affected as a result of this variable as it appears common to all subdivisions.

Socio-economic factors

The most prevalent social variables utilized in adoption studies are social group membership, perceptions of soil erosion, attitude toward the profitability of conservation techniques and participation in shared labor for SWC management. In view that 78% of the households in the total sample are members of particular community organizations, such as members of associations, cooperatives and other local institutions, 57% participated in labor sharing groups for the management of community-level SWC practices and 87% of them had awareness on the problem of soil erosion. Furthermore, more than 82% of farmers reported that SWC practices solve erosion problems as well as provide a positive return on investment in terms of productivity improvement. Similarly, farmers were expected to walk on average for 7.6 km to get access to local market areas. Only 29% of them had off-farm activities (such as petty trade, daily laborer, selling charcoal, wood, pole and others). The average annual income received from selling crop products and livestock sources (including livestock and their products) was 7,190 Birrs and 2,951 Birrs, based on the 2019 average market price. This shows that the dominant sources of income for households included in the sample were sourced from crop production. The average tropical livestock owned by sampled households is estimated to be 3.09 units (Table 2).

The findings further show that there are significant differences in the entire socio-economic variables across adoption stages. At a 1% significance level, the proportion of households who were members of different associations and cooperatives sharply decrease as one progresses from adoption to dis-adoption stages in both the total and disaggregated samples. Likewise, the number of farmers who had a thorough understanding of the subject of soil erosion generally declines significantly (at a 1% significance level) but with fluctuating intragroup trends. The share of households who reported that SWC practices provide a positive return on investment also significantly varies as adoption level changes. Such trends indicate that those not involved in community groups, are less aware of the problem of soil erosion, have a negative attitude toward the benefits of implemented remedies and participated in labor sharing groups are expected to become dis-adopters.

The most common economic variables considered in adoption literature are access to the market, roads, off-farm job opportunities, income from agricultural sources and ownership of farming tools and domestic animals. In all economic factors, there were substantial variations across adoption stages at a 1% level of significance. Given that, farmers in adoption categories were expected to walk long distances to reach market areas and all-weather roads than those in acceptance and dis-adoption levels in each as well as in the general sample. However, only a small percentage of them had off-farm opportunities. This demonstrates that dis-adopter farm households are those that are somewhat close to marketplaces, where more off-farm possibilities are accessible which potentially is diverting the essential labor force away from conservation efforts. The average annual incomes received from selling crop products and from animal sources have also been lower for dis-adopters than for actual level adopters. The numbers of farming tools and livestock as measured by tropical livestock units (TLU) were smaller for the same groups. This means that if such elements decrease or disappear, the risk of the SWC measures being abandoned increases.

Farm-related factors

Plot characteristics such as farm size, land fragmentation, land productivity, slope, soil fertility status, the risk of flooding and average distance to farm plots are determinants affecting the use of conservation measures. The average farm size per household in the pooled sample size was 1.29 ha, of which the amount treated with SWC measures was 0.65 ha. The average land fragmentation measured by the number of plots divided by farm size was 2.74 units. On average, 20% of farmers in a pooled sample size were perceived to operate on gentle slope farmland. This shows that more than 80% of the targeted study area is sloppy and needs a conservation structure. Concerning soil fertility, smallholders in the entire sample perceived only 16% and 22% of having very good soil fertility status and had faced the lowest level of flood risks, respectively. This shows that almost 84% of the land has soil fertility problems and 78% of the farmland in the study area is subjected to soil erosion resulting from the risks of flooding. Smallholders were also expected to walk, on average, for 15 minutes to manage their farm plots (Table 2).

As far as the adoption categories are concerned, the average farm size per household in the pooled as well as in the discrete samples was found to be significantly different among the adoption stages. Adopters tend to have larger farm sizes per hectare and land-to-family size ratio as compared to dis-adopters. This supports the premise that small farms will not provide operators with more decision-making flexibility and resources to make use of innovative techniques (Amsalu and de Graaff, 2007). Additionally, the farmers stated that the loss of land due to SWC practices and temporal productivity losses discouraged them from progressing with introduced measures. This shows that the smaller the land size the higher the probability of smallholders being converted into dis-adopters. Researchers found that farmers who have small farm sizes are less likely to invest in soil conservation structure maintenance (Kebede et al., 2016; Limani, 2018). The average land fragmentation is consistently increasing as one moves down from the actual adoption stages to the dis-adoption stages. Similarly, the former group enjoys a higher level of land productivity (total production valued with Monterey terms per hectare) as compared with the latter. This elucidates that these variables in one way or another affect the probabilities of households discontinuing already accepted SWC measures.

In the same way, more proportion of dis-adopters was operating plots on relatively flat slopes and low flood risk areas than acceptance and actual level adopters respectively. In other words, a large number of the latter group operates on farms found on steep slopes and high flood risk areas compared with the former. Likewise, it seems that a relatively large number of dis-adopters operate in high fertile plots than actual-adopters. The test statistics result also shows that there are significant differences among adoption phases as far as soil fertility status is concerned.

Adoption stages

Adoption of SWC measures is typically a multistage process that is often carried out sequentially (de Graaff et al., 2008; Teshome et al., 2016). According to Rogers et al. (2014), an adoption decision is a multistage process undertaken most often sequentially involving knowledge, persuasion, decision, implementation and confirmation (Ng, 2020; Soliman and Rinta-Kahila, 2020). The last two stages are related to post-adoption decision behaviors, which are very much related to the interest of this study. The implementation stage is associated with the acceptance or trial period of SWC technology, while the confirmation phase is related to the decision to continue using or discontinue using SWC technology (Frei-Landau et al., 2022). According to Huria et al. (2019), Roger suggested that discontinuance occurs at each stage in the adoption process. This implies that a farmer may discontinue the introduced SWC measures either from trial/acceptance or full adoption stages.

Table 2. Descriptive analysis of households' attributes

Variables	Sebeta-Hawas (N = 249)			Kewet (N = 276)			Pooled sample (N = 525)				
	dis.	acc.	ado.	dis.	acc.	ado.	dis.	acc.	ado.	F/χ2	mean
Sex	.83	.82	.89	0.81	.82	.93	.83	.82	.92	.007	.88
Age	45.1	46.3	46.5	49.3	54.8	44.9	46.7	49.5	45.52	.003	46.33
Grade	3.27	3.82	3.31	3.15	3.00	2.67	3.23	3.51	2.93	.194	3.08
Family size	4.09	5.08	5.68	4.84	5.61	5.38	4.38	5.28	5.50	.000	5.22
Full-time labor size	1.32	1.96	2.89	1.36	1.82	2.51	1.34	1.91	2.65	.000	2.26
Tenure security	.70	.61	.90	.93	.89	.98	.79	.72	.95	.000	.88
Training	.75	.80	.98	.77	.99	.95	.76	.88	.96	.000	.91
Assistance	.85	.74	.64	.52	.79	.55	.72	.76	.59	.002	.64
Access to DAs	.85	.96	.98	.98	.96	.93	.90	.96	.95	.064	.94
Credit access	.39	.39	.47	.48	.25	.55	.43	.34	.52	.010	.47
Social group	.42	.76	.90	.73	.75	.85	.54	.76	.87	.000	.78
Erosion problem recognition	.75	.72	.93	.86	.86	.90	.79	.77	.91	.000	.87
SWC profitability	.66	.76	.94	.73	.79	.85	.69	.77	.88	.000	.82
Labor sharing	.42	.50	.83	.52	.50	.49	.46	.50	.62	.004	.57
Access to market km^{-1}	3.24	4.35	7.01	4.21	5.43	11.43	3.61	4.76	9.69	.000	7.66
Access to road km^{-1}	2.50	2.78	3.40	4.73	7.09	9.06	3.35	4.41	6.84	.000	5.74
Off-farm work	.73	.61	.19	.20	.50	.13	.53	.57	.15	.000	.29
Income from crop (ETB)	2,323	6,206	8,738	2,079	5,678	9,432	2,230	6,006	9,159	.000	7,197
Farming tools (number)	2.78	3.48	4.09	5.25	5.35	5.83	3.73	4.19	4.99	.000	4.6
Income from livestock (ETB)	1,511	2,998	3,828	1,491	2,792	3,209	1,504	2,921	342	.000	2,950
Livestock holding (in TLU)	1.90	2.88	3.91	2.32	3.03	3.20	2.07	2.94	3.48	.000	3.09
Farm size/ha	.62	.1.43	1.73	.65	1.04	1.36	.63	1.28	1.51	.000	1.29
SWC treated farm size ha^{-1}	.04	.32	.98	.07	.23	.90	.05	.29	.94	.000	.65
Land fragmentation	3.82	2.42	2.18	4.31	3.02	2.41	4.00	2.64	2.32	.000	2.74
Land productivity (quint ha^{-1})	4.41	5.72	5.25	5.00	7.71	6.41	4.47	6.48	5.95	.000	5.7
Gentle slope	.34	.28	.14	.43	.29	.12	.37	.28	.12	.000	.20
High fertility	.21	.17	.12	.29	.14	.14	.24	.16	.13	.018	.16
Low flood risk	.37	.26	.12	.43	.39	.16	.39	.31	.14	.001	.22
Distance to plots km^{-1}	19.34	19.86	16.13	13.37	15.47	12.07	17.06	18.21	13.83	.000	1.02
N	71	46	132	44	28	204	115	74	336		

Note: dis. = dis-adopters; acc. = acceptance (pilot) level adopters; ado. = adopters and continuous users

In view of this theoretical framework, the unconditional probabilities presented in Table 3 show the proportion of households belonging to each adoption stage. Of the total sample size, about 22.9% of them were found to be dis-adopters, 14.1% remained as pilot-level adopters and 64.0% were actual or progressive adopters who covered more than 26% of sloppy plots with SWC measures with or without project interventions. Regarding the disaggregated sample, Sebeta-Hawas farmers were higher (28%) in terms of average numbers of dis-adopters than Kewet households (15%). In the same way, at the adoption level, the share of the former was smaller (53%) than the latter (73%). This shows that the numbers of farmers in Sebeta-Hawas were declining in the absence of government and non-governmental organizations' and intervention.

According to qualitative information collected from farmers and experts, smallholders are forced to abandon already established structures for several reasons. First, they stopped implementing the measures because their conservation efforts did not result in increased yields. That was due to most of the SWC efforts focused on reducing soil erosion rather than enhancing productivity, particularly in the Sebeta-Hawas. Soil replenishment functions such as the use of compost, manure and other land management systems were not integrated with the introduced measures. Respondents also claim that structures were taking up space on the small plot size that could have been used for production. In addition, in some areas, the land was found to have been degraded heavily to easily recover and return to its natural state. When land resources are severely degraded, restoring their productive capacity is very unlikely (Mekuriaw and Hurni, 2015). This finding is also consistent with Rogers et al. (2014) theoretical proposition, saying that when individuals are satisfied with whatever new technology they have adopted, they are likely to hold on to it, but if they feel that it does not meet their needs, they will discard it.

Second, a lack of sustainability and follow-up strategies to enhance adoption and SWC practice implementation was also the other reason stated for dis-adoptions. According to Das and Rahman (2018), post-adoption extension visits help to strengthen farmers' confidence in the benefits of their adoption efforts. Third, some respondents cited a lack of interest as a cause for their discontinuance. They first adopted the innovations because they had attended training, were forced (incentivized) and saw when others were implementing the measures without having the real intention of embracing them. Lack of interest, however, was not a serious problem for farmers operating in Kewet Districts. Incompatibility of the measures with their experience was also stated as a reason for dis-adoption. The new soil conservation activities have been implemented without regard to farmers' involvement in decision-making procedures (Debie, 2021). Top-down approaches and failure to consider farmers' actual participation in SWC activities obstruct the implementation and development of SWC innovations. Fourth, another factor stated was that maintaining and advancing with the measures need intensive labor power and is costly.

Factors influencing dis-adoption decisions

The purpose of this section was to investigate factors that influence farmers' dis-adoption decisions of SWC practices in the study area using an ordinal regression model. Dis-adoption in this paper refers to the gradual abandonment of previously accepted and adopted SWC measures. According to Huria et al. (2019) and Singh et al. (2020), technology discontinuance can occur shortly after a trial period or after an extended period of continued use. In view of that, the dis-adoption process could take the following sequences: adoption, acceptance/ initial adoption and dis-adoption. The ordinal logistic regression result based on the entire sampled households (N = 525) shown in Table 4 presents model assumptions, log odd coefficients, standard errors, odds ratios (OR) and significance levels. For ease of interpretation and to fit into model requirements, the dependent variable was categorized and ordered as follows: adoption = 1, acceptance/initial level of adoption = 2 and dis-adoption = 3, where 3 indicates lower and 1 indicates higher adoption category. Here, dis-adoption was used as the variable of interest and other categories are reference units used to determine the effects of useful interdependent variables.

Table 3. Unconditional probabilities of adoption categories

Adoption categories	Sebeta-Hawas		Kewet		Total sample	
	Count	Percent	Count	Percent	Count	Percent
Dis-adopters	71	28.2	44	15.9	115	21.9
Acceptance/pilot adopters	46	18.8	28	10.1	74	14.1
Adopters	132	53.0	204	73.9	336	64.0
N	249	100.0	276	100.0	348	100.0

Before interpreting the results, interdependence (multi-collinearity) among variables and the ordinal logistic regression model assumptions were tested. As recommended by Tabachnick and Fidell (2007), independent variables with a high degree of correlation (r > 0.70), tolerance value (0.1), VIF (> 5.00) and low levels of coefficient values were excluded from the ordinal regression model. Farm size, for example, was found to be significantly correlated with land fragmentation, whereas family size was found to be substantially linked with full-time farm labor. Out of the 30 variables discovered at the outset, only 21 were chosen to be included in the model because of the multi-collinearity issues. The findings presented in Table 4 also indicate that the proportional odd assumption required for the ordinal regression model was satisfied (p-value = 0.095), at a 5% significant level. According to Hosmer and Lemeshow (2000), the model requires that the explanatory variables have the same effect on the odds regardless of separate intercept terms. The higher the p-value, the better it suggests that the assumption is met. In terms of predictive power, the model is likely to be a good predictor (R^2 = 0.52) for estimating the impacts of independent variables. As far as the model fitness is concerned, the finding revealed that the differences between 2 times the log-likelihood for the intercept-only model and the final model are significant at a p-value of 0.000. That shows that the model gives better predictions than just guessing based on probabilities for the outcome categories.

Findings presented in Table 4 also demonstrate econometrics results of the predictors related to demographic characteristics, institutional, socio-economic and plot characteristics. From the hypothesized independent variables, the household's head sex, age, full-time labor, incentives, training, access to the local market, livestock holding, perception of soil erosion, participation in shared labor, land fragmentation, plot slopes and flood risks were found to significantly affect dis-adoptions decisions.

Sex

The findings show that the gender of the household head is significantly and negatively associated with dis-adoption. This implies that male-headed households are less likely to abandon the use of SWC activities compared to their female counterparts. According to Asfaw and Neka (2017) and Nkonki-Mandleni et al. (2022), households headed by women are less likely to invest in SWC structural maintenance due to a lack of labor, less access to information and the fact that they bear additional in-house responsibilities such as cooking and taking care of the family members. This result is consistent with previous research (Gedefaw et al., 2018; Limani, 2018; Ewunetu et al., 2021; Oduniyi, 2022), which found that male-headed households are more likely to use structural SWC practices but contradicts the findings of other studies (Atnafe et al., 2015; Belachew et al., 2020) that more female-headed households are probably continuing with technology use than males.

Age

It was also identified that age has a significant and favorable influence on farmers' decisions to abandon SWC measures. The positive coefficient and odd ratios reveal that as the age of a household increases, the likelihood of the household gradually abandoning the accepted SWC measure also rises. This indicates that older households are more susceptible to dis-adoptions than younger households. This finding is also consistent with what was found by Wolka and Negash (2014); Asfaw and Neka (2017); Gedefaw et al. (2018); Byamukama et al. (2019) and corroborates with the descriptive analysis result reported in Table 2. As per these authors, older household heads are probably physically weaker and more resistant to change and hence less interested in adopting and maintaining SWC practices. However, the result is inconsistent with the results of prior studies (Agidew and Singh, 2018; Mekuriaw et al., 2018; Oduniyi, 2022) that older farmers are more experienced in perceiving erosion and limited participation in off-farm activities and hence are good in conservation investment.

Labor

In this study, the number of active full-time farm laborers was found to negatively and significantly contribute to households' SWC technology adoption discontinuance decisions. The model result implies that as the sizes of active farm laborers are smaller, the probability of abandoning the use of SWC structures is higher. That is because investments and maintenance of SWC activities are highly laborious (Teshome et al., 2016; Sileshi et al., 2019). The positive influence of labor size on adoptions of SWC was confirmed by a study conducted in Eastern Ethiopia (Wordofa et al., 2020), northern highlands (Belachew et al., 2020), North West highlands of Ethiopia (Debie, 2021) and the Tigray region of Ethiopia (Etsay et al., 2019). The household size was also found to have a beneficial effect on SWC adoption (Darkwah et al., 2019; Mengistu and Assefa, 2019; Yifru and Miheretu, 2022).

Training

The training is intended to have a beneficial impact on SWC practice adoption (Ewunetu et al., 2021). The findings read from Table 4 further reveal that the training exposure of households to various SWC measures and associated benefits negatively and significantly affected the probability of households' being in the dis-adoption category. This implies households who have been given consistent training are less likely to be in the dis-adoption category than those who did not receive training. This shows that non-trained households are more likely to abandon or reject already accepted SWC technologies as compared to trained households. This finding is in line with the findings of Asfaw and Neka (2017); Belachew et al. (2020) and Goba et al. (2022) that farmers who did not participate in the SWC training provided are less likely to embrace, use and apply SWC methods. This suggests that SLM-related training is one of the decisive factors for smallholder farmers' arrest dis-adoption. The knowledge and skills obtained from extension workers and training improve farmers' decisions and execution of SWC technologies.

Incentives

The different kinds of assistance provided to initial level adopters by non- governmental and governmental organizations positively and significantly affected technology dis-adoption. The positive coefficient sign and the odd ratio show that households with assistance history are more likely to be in a dis-adoption category than those without assistance. This shows that different kinds of incentives provided to stimulate pilot-level adoption make beneficiaries dependent on incentives and leave them worse off when the project is over. Based on interviews conducted with farmers and development agents, materials and financial assistance supplied to adopters by non-governmental organization and the government inspired them to practice the SWC measures. Later, when incentives cease to exist, they lose motivation to continue working on them. This shows that introducing SWC technologies without incentives is helpful for progressive adoption to prevail and for the measures to be successful and achieve the intended results. This finding is consistent with what was reported by de Graaff et al. (2008), claiming that farmers who are not fully convinced of the effectiveness of the measures may not often use the new technology. However, it contradicts the result found by Teshome et al. (2016) describing a positive influence on the probability of continued adoption.

Market access

The results presented in Table 4 indicate a significant inverse relationship between market access and technology dis-adoptions decisions. The negative coefficient implies that if the distance to local market areas increases, then the likelihood of the households being in the no-adoption stages decreases. In other words, better access to the market promotes the possibility of dis-adoption as it increases the possibility of non-farm opportunities, which eventually plays a role in reducing the intensity of the applications of SWC conservation technologies. Thus, the result is consistent with the findings of Wolka and Negash (2014) that households farther from the market were more likely to invest in the maintenance of conservation practices but contradicts Ewunetu et al. (2021) and Yifru and Miheretu (2022) that market proximity encouraged investment in SLM to have the high possibility to sell the product at a favorable price and general accessibility of inputs.

Table 4. Determinants affecting households' dis-adoption decisions

Variables	β	St. err	Wald	χ2	OR
Household head's sex	-.845	-.388	4.75	.029	.429
Household head's age	.046	.016	7.87	.005	1.05
Household head's grade	.092	.053	3.37	.066	1.09
Full-time labor size	-.718	.192	13.9	.000	.488
Tenure security	-.729	.441	2.73	.098	.483
Training access	-1.99	.465	18.5	.000	.136
Assistance	.939	.330	8.08	.004	2.56
Contact with DAs	-.097	.575	0.029	.866	.907
Credit access	.170	.309	.302	.582	1.19
Access to market km^{-1}	-.354	.053	44.1	.000	.702
Off-farm income	-.117	.303	.145	.704	.889
Tropical livestock units (TLU)	-.671	.181	13.7	.000	.511
Social group membership	-.297	.413	0.520	.471	.743
Soil erosion problem recognition	-2.25	0.414	29.5	.000	.105
SWC profitability	-.042	.459	.008	.928	.959
Labor sharing	.720	.356	4.09	.043	2.06
Land fragmentation	.890	.140	40.3	.000	2.43
Gentle slope	.810	.321	6.35	.012	2.25
High soil fertility	-.145	.357	.164	.685	.865
Low flood risk	1.02	.317	10.3	.001	2.76
Average distance to plot km^{-1}	0.15	.273	.003	.956	1.01
Treshold1	-3.908	1.491			
Treshold2	-2.052	1.477			
Model fit (-2 LL)	Intercept only = 939, Final model = 448, chi^2 (21) = 490, p-value = 0.00				
Pseudo-R^2	0.522				
POM	Null = 448, -2LL = 418, chi^2 = 29, p-value = .095				

Livestock (TLU)

Livestock production is an essential part of the study area's mixed farming systems. It significantly and negatively influenced dis-adoption. The negative coefficient in the model shows that a farmer with a large number of livestock is more likely to be engaged in the maintenance and replication of SWC measures than those with smallholders. This was confirmed from the interview conducted that the farmers holding large cattle populations usually satisfy the demand for fodders and grass from SWC structures and hence invest in structural maintenance. Thus, farmers with fewer numbers of tropical livestock are more likely to gradually reject already accepted SWC practices. This result is more or less similar to the findings of other studies (Kebede et al., 2016; Toma et al., 2017; Belachew et al., 2020; Ewunetu et al., 2021) but contradict what was found by Miheretu and Yimer (2017) and Agidew and Singh (2018), which concluded that the effect of livestock size on adoption decision was significantly negative.

Recognition of soil erosion problem

Household perceptions of soil erosion as a problem and dis-adoptions had a significant negative causal link. By implication that farmers who realize the problem of soil erosion are less likely to abandon the accepted SWC technologies than those who do not. The negative impact of households' perception of soil erosion problem is confirmed by Miheretu and Yimer (2017) and Yifru and Miheretu (2022). In the descriptive result of this study, the numbers of farmers who perceived that there exists a problem of soil erosion are less compared with adopters.

Participation in shared labor

Participation of households in shared labor for SWC practices was found to have a positive association with discontinuance decisions. According to qualitative data acquired through interviews with respondents who participated in labor-sharing activities, they were involuntarily influenced by the government in a campaign to accept the measures. As a result, most of them choose to get rid of the structures on their farmland instead of maintaining the introduced measures as they considered it a waste of time and a politically motivated practice to be done for the sake of a government. According to Teshome et al. (2016) and Tolassa and Jara (2021), the performances of SWC practices are less effective because mostly carried out in campaigns without full participation and sufficient recognition of the beneficiaries' interests. This shows that those smallholders with labor-sharing participation history had more probability of being dis-adopters in the absence of intervention efforts. That could be because of farmers' negative attitudes toward the program or lack of information on the long-term benefits program (Agidew and Singh, 2018). This finding contradicts with Kipsat et al. (2021), who reported that membership in the SWC group helps to sustain adoption.

Land fragmentation

The likelihood of a household being a dis-adopter was greatly influenced by land fragmentation. This demonstrates that the more farmlands are broken into more plots separated from one another, the higher the likelihood of the household abandoning the accepted SWC practices. According to Ewunetu et al. (2021), fragmented plots waste more time and labor needed to maintain and manage SWC activities at each plot. This result corroborates with findings of Wolka and Negash (2014) and Sileshi et al. (2019) that a small number of fragmented lands increase the likelihood of SWC technology adoption by implication that the greater the fragmentation, the higher the probability of the household being in the dis-adoption category.

Slop and flood risks

Plot characteristics such as gentle slope and low flood risk status have substantial positive effects on the probability of adoption discontinuances of SWC practices. According to the POM model, farmers cultivating on a gentle slope or in a low-flood-risk location are more likely to be dis-adopters than those cultivating medium and steeper plots in high-flood-risk areas. Based on the qualitative information collected from study participants, farmers want to avoid SWC from the farms in a gentle slope plot because it conserves too much water during the rainy season to the extent that it impedes mobility during the cultivation period and productivity. However, those operating at steeper plots want the structure to control floods and hold moisture. This result is consistent with Atnafe et al. (2015); Limani (2018); Sileshi et al. (2019); and Goba et al. (2022) that gentle slope and low flood risk areas are not thought to be more prone to soil erosion for farmers to embrace SWC practices.

The other variables such as education, contact with extension agents, tenure security credit availability, membership to different local groupings, off-farm employment and distance to farm plots had no significant influence on the farmers' dis-adoption decisions at a 5% significance level. The insignificant effects of education and access to extension agents are probably because of the fact that they do not meaningfully vary among adoption categories as was indicated in the findings presented in Table 2. Apart from that, there were low levels of overall average education among farmers in the study area. According to Wolka and Negash (2014) and Mekuriaw et al. (2018), education has little or no association with the adoption of SWC practices, due to the generally low level of rural households' education. Nevertheless, one of the important questions to be asked here is "why do some people dis-adopt measures while others do not?" given a high level of access to extension agents in the study areas as was seen in the descriptive analysis of this study. This is because extension agents provide support for crop production (through the provision of fertilizers and improved seeds) and livestock rearing than enhancing already adopted conservation practices. This finding is consistent with Limani (2018); Kipsat et al. (2021); and Goba et al. (2022) that access to extension agents has insignificant impacts on SWC measure adoption continuity. Nonetheless, it is not sufficient to have extension support but the aim or purpose of extension service should also relate to the continuation of dis-adoption of conservation work (Byamukama et al., 2019).

The insignificant impact of credit on the discontinuance of SWC adoption decision is in line with (Agidew and Singh, 2018) who observed that credits contribute to farm input purchase than reinforcing conservation practices. Tenure security was not found to have significant influences on the probability of dis-adoption. This finding seems inconsistent with the results of studies conducted by Belay and Bewket (2013); Byamukama et al. (2019) and Wordofa et al.

(2020), which found that lack of tenure security affects farmers' decisions to initially adopt conservation measures. The off-farm activity was not also found to influence the dis-adoption decisions. That means, that because of off-farm employment, farmers may not move to the dis-adoption level or fail to maintain the existing structures. These findings contradict the results of previous research on the influences of off-farm income farmers on SWC measure adoption (Amsalu and de Graaff, 2007; Mekuriaw et al., 2018). The finding on membership to different local groups is in contradiction with Teshome et al. (2016) that the number of farmers participating in different groups influences the continuous adoption of SWC measures.

CONCLUSIONS

SLM adoption initiatives reduce food insecurity and poverty if applied continuously and consistently. However, mentionable numbers of households abandoned previously accepted SWC technology in the study regions. The econometric results have confirmed that insufficient recognition of soil erosion risks, lack of training and availability of incentives substantially affect dis-adoption decisions. Additional impacting factors are land fragmentation, female-headed households, labor shortages and gentle slope locations. Qualitative information sources have also revealed that low agricultural productivity, a lack of amalgamating structures with production enhancement activities and the absence of post-adoption follow-up are the reasons for adoption discontinuances. Thus, policymakers should consider these variables in designing strategies to overcome barriers to SLM practice.

ACKNOWLEDGEMENT

The authors would like to acknowledge the Kowet and Sebeta-Hawas District sustainable land management project focal persons, development agents and farmers who have supplied valuable information for this study. In addition, our appreciation goes to the Addis Ababa University for the financial support given to conduct the fieldwork.

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