Factors Influencing Adoption of Improved Structural Soil and Water Conservation Measures in Eastern Ethiopia

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Abstract

Background

Agriculture remains to be the leading sector that contributes enormously to economic development in Ethiopia. Despite its significant contribution to livelihoods, the sector faces persistent challenges due to depletion of natural resources and soil erosion that resulted in diminishing crop and livestock productivity. In order to curb the effects of land degradation, the Government of Ethiopia has been taking serious measures to expand Soil and Water Conservation (SWC) practices throughout the country. Despite the efforts made, the adoption of new practices by farmers have been generally low. This study was aimed to assess factors influencing smallholder farmers’ decision on the use of improved structural SWC practices in Haramaya district, eastern Ethiopia. A multi-stage sampling technique was used to select 120 farm households and 248 plots. A structured interview schedule was used to collect primary data. Descriptive and inferential statistics and Multinomial Logit (MNL) regression model were used to analyze the data.

Results

The key findings showed that a host of socio-demographic, economic and institutional factors significantly affected smallholders’ decision to adopt improved structural SWC. In this study, we found that education, farming experience, plot area, distance of the plot from dwelling, number of economically active household members, and extension contact were the significant predictors of using improved SWC structures.

Conclusions

Based on our findings, we conclude that improved SWC measures should be scaled up through a concerted effort of extension workers, local administration and other relevant non-state actors. In particular, the extension system should encourage rural communities on sustainable management and use of natural resources. Moreover, the need to create learning opportunities through facilitating appropriate training programs for farmers and focusing on proper management of available economically active household members should be emphasized.

Background

Agriculture remains to be the leading sector that contributes enormously to economic development in Africa (Belachew et al. 2020; Collier and Dercon 2014). More importantly, throughout Sub-Saharan
Africa (SSA) region, the sector is hailed as the main engine of economic growth and poverty reduction. Despite its significant contribution to livelihoods, the sector faces a persistent challenge due to depletion of natural resources and soil erosion (Belachew et al. 2020; Kagoya, Paudel and Daniel 2017), climate change induced phenomena, and scarcity of modern/productive inputs, to mention but a few. As an agrarian nation, Ethiopia’s fast-growing economy is facing similar challenges due to lingering soil erosion and land degradation (Asnake et al. 2018; Fontes 2020). This has resulted in reduced crop and livestock productivity and increased food insecurity and poverty.

Soil degradation especially in the highlands of Ethiopia continues to be a serious threat to subsistence agriculture, which is the backbone of the economy. It has to be noted that 90% of the population lives in the highlands where land is continually cultivated and, as a result, is highly prone to soil erosion and land degradation (Daniel and Mulugeta 2017). The situation in Haramaya district, the study area, is not different from the rest of the country. Haramaya district faces food production problems, mainly due to physical and man-made causes. The man-made problems include overgrazing, overcultivation, deforestation and inappropriate agricultural practices. The physical factors include climate change, intensity of rainfall, topography and others. These have resulted in enormously degraded land, which seriously threatens smallholders’ welfare in the district.

In order to curb the effects of land degradation, the Government of Ethiopia (GoE) has been taking serious measures. One of the strategies has been expanding SWC practices throughout the country (Adimassu et al. 2014). The GoE, through its Productive Safety Net Program (PSNP) and other initiatives, has been promoting terracing, soil and stone bund, mulching, composting etc to individual and communal lands (Yitayal and Adam 2014). Such practices are proved to be effective in reducing soil erosion and improving soil nutrient availability (Haregeweyn et al. 2015). However, the effectiveness of the government’s efforts to promote improved structural SWC measures has not been adequately studied across the various agro-ecological zones of the country. Hence, a scanty empirical evidence exists on the status of adoption and impact of improved structural SWC measures across various contexts.

Recent empirical investigations highlight the usefulness of SWC practices in enhancing productivity
and improving smallholder livelihoods (e.g., Haregeweyn et al. 2015; Karidjo et al. 2018).

Nevertheless, in spite of the efforts made to popularize the use of such measures, adoption and wider usage is not widespread among farmers in Ethiopia (Asnake et al. 2018; Kirubel et al. 2012). This is partly due to lack of active participation of smallholders. In Haramaya district, both traditional and modern SWC structures have been practiced by some farmers, but not to a satisfactory level. More importantly, the rate of adoption of improved structural SWC practices in the district has not been sufficient enough to safeguard smallholder livelihoods against crop loss, food insecurity and abject poverty.

There are several studies documenting the socio-demographic, economic, institutional and biophysical factors that influence farmers’ decision to use improved agricultural technologies (for instance, Daniel and Mulugeta 2017; Yitayal and Adam 2014). However, research on adoption of improved SWC practices among smallholders are limited. In Haramaya district, such studies have not yet been sufficiently conducted. Such investigations are vital for selecting relevant conservation methods and interventions to encourage active participation as well as designing and implementing appropriate policies and strategies (Asnake et al. 2018). Therefore, the current study was conducted to identify factors affecting adoption of improved structural SWC practices among smallholder farmers in the study area.

Methods
Description of the study area
This study was conducted in Haramaya district which is located at a distance of 510 km away from Addis Ababa along the main road towards Harar town. It is one of the 19 food insecure districts of east Hararghe zone of Oromia regional state. It has 33 rural kebeles. The district lies between $9^\circ 09`$ and $9^\circ 32`$ N latitude and $41^0 50`$ and $42^0 05`$ E longitude to the west of Harar town. It is bordered by Dire Dawa Administrative Council in the north, Kombolcha district in the north east, Harari Peoples’ National Regional State in the east, Fedis district in the south east, Kurfachele district in the south west and Kersa district in the west. From the total area of 521.63 km$^2$, 36.1% is arable or cultivable, 2.3% is pasture, 1.5% is forest, and the remaining 60.1% is considered built-up, degraded or
otherwise unusable (Haramaya District Agricultural and Rural Development Office (HDARDO) 2014). The total population of the district were 271,018 persons of which 138,282 were men and 132,736 were women; with an average family size of five. The majority of the populations (96.7%) are Muslims, while 2.7% of the population practices Orthodox Christianity and 0.6% is others. Of its total area, 90% is mid-highland while the remaining 10% is lowland. The predominant soil types of the district are Rigo soil (Haramayan series) 60% and heavy black clay soils (Vertisols) 40%. Soil texture is sandy loam. From the total land area, 36.1% is arable or cultivable, 2.3% is in pasture, 1.5% is forest, and the remaining 60.1% is considered built-up, degraded or otherwise unusable (HDARDO 2014).

Rainfall is bimodal, and the mean annual rainfall is 492 mms ranging from 118-866 mm. The short season (Badheessa), rain usually starts in March and ends in May, and the long season (Ganna) rainfall occurs to June and September. Relative humidity varies from 60 and 80%. Minimum and maximum annual temperatures range from 6°C to 12°C and 17°C to 25°C, respectively (Haramaya District Finance and Economic Development Office (HDFEDO) 2014).

Agriculture is the mainstay of the economy of the total communities. It is carried out by those who have land and livestock. Some landless are engaged with sharecropping and other non-agricultural income generating activities like daily laboring, pity trading etc. crop production and animal husbandry are the major activities undertaken to meet the economic sector. The dominant crops grown in the study district are sorghum, maize, potato, sweet potato, haricot beans, vegetables and khat. Vegetables and khat are the two major cash crops grown in the area (HDARDO 2014).

The primary cash crop in the district is khat which does have years round availability and able to fetch attractive market price in all the seasons of the years regardless of the rainfall availability unlike the food crops. Food crops commonly assume poor production status because of the fragmentation of land, shortage of motor pumps and diversion of attention to cash crop khat. Livestock are valuable components of the farming system contributing enormously to insuring food security. The major livestock production actively practices are: cattle production for milk production and fattening, small ruminants (Sheep and goat), poultry and donkey for transport facility. The main problems in the
district's livestock production sector are shortage of feeding because of over degradation and scarcity of grazing lands (HDARDO 2014).

Agricultural extension services are very important to assisting farmers by identifying and analyzing their production problems and by making them aware of opportunities for improvement. It plays significant role in increasing crop production of the use of improved seeds, fertilizers, chemicals and improved farming systems. Currently, the focus on the agricultural extension services in the district is on crops, livestock and natural resources in an integrated development approach. With regard to give extension services for 36961 extension user households, there are 126 Development Agents (DA), who live within the Kebeles, provide extension services in the district. The farmer-DA ratio is one important issue, which needs attention (HDARDO 2014).

Sampling technique
A multi-stage sampling technique was used to select sites and draw households for the study. First, Haramaya district was selected purposively due to the high soil erosion problem. Then three kebeles were selected randomly. Finally, probability proportional to size and simple random sampling were used to draw sampled households from each kebele. To identify households, a list of names of household heads was taken from the District Office of Agriculture and Natural Resources as well as the records of DAs. In all the sampled kebeles the upper, middle and lower slope reaches of the watershed were covered during data collection. This study applied a simplified formula provided by Yamane (1967) to determine the required sample size.

\[
n = \frac{N}{1 + N(e)^2}
\]

where:

- \( n \) is the sample size,
- \( N \) is the population size, and
- \( e \) is the level of precision (0.09).
Based on this formula a total of 120 sample households and 248 plots were used in this study (Table 1).

| List of Kebeles | Total household heads | Sampled household heads |
|-----------------|-----------------------|-------------------------|
| Kersa Getete    | 766                   | 37                      |
| Damota          | 1074                  | 51                      |
| Finkle          | 667                   | 32                      |
| Total           | 2507                  | 120                     |

Source: Own survey, 2017.

Data collection and analysis

Both qualitative and quantitative data were collected from primary and secondary sources through field observation, structured interview schedule and Focused Group Discussions (FGDs). Qualitative data were collected from elders, selected farmers and key informants who have an adequate knowledge and information about the past and present condition of the study area. The knowledge and information these people include natural resources, agricultural production, land use, land management practices, causes, extents, and consequences of soil erosion, SWC practices, local labor organization and institutional support. The quantitative primary data include household characteristics (age, education, farming experiences, family size, marital status), farm characteristics (number of plots, source of farm plot, slope, soil fertility, soil colour, farm size, distance of farm plots from home), perception on soil erosion, causes, extents and consequences of soil erosion, SWC practices, labor availability, land tenure issue, agricultural extension and credit. Secondary data were obtained from published and unpublished sources.

Qualitative data were analyzed through interpretation and conceptual generalization. For quantitative data, both descriptive statistics and the standard Multinomial Logit (MNL) model were implemented on STATA 11. The MNL model was used in this study to assess factors affecting farmers’ adoption of improved SWC practices because the dependent variable takes more than two values: traditional or no conservation strategy, improved soil bund, improved stone bund, and improved check dam.

Households and plots were used as a unit of analysis because the focus of the study is on SWC technologies that were observed at the plot level and the dependent variable was also measured at the same level. This level of analysis is advantageous because it captures more spatial heterogeneity and also helps to control for plot level covariates and hence helps to minimize the omitted variable
bias that would confound household level analysis (Sarantakos 1999).

Factors affecting farmers’ perception on adoption of improved SWC technologies are inherently a multivariate decision. Attempting bivariate modeling excludes useful economic information contained in the interdependent and simultaneous adoption practices (Wagayehu 2003). It is more appropriate to treat adoption of improved SWC measures as a multiple choice decision. Hence, in this study a MNL model was used to estimate the coefficients and marginal effects of farmers' adoption of improved soil bund, improved stone bund, and improved check dam in the study area. In this study, adoption is regarded as the existence of one or more improved structural SWC structures on farmers plot. The independent variables, hypothesized to have relationship with the dependent variable, were carefully chosen based on previous empirical research (Table 2).

Following Gujarati (1995), multicollinearity problem for continuous explanatory variables was assessed using Variance Inflation Factor (VIF) and Tolerance Level (TOL) are computed. Similarly, in order to see the degree of association between dummy and discrete variables, Contingency Coefficient (CC) was computed. The result of these tests showed the absence of multicollinearity problems in the dataset.

Result And Discussion
Descriptive results
The results of descriptive analyses on personal and demographic, economic, biophysical, institutional and behavioral characteristics of the sampled farm households is given in Table 2. The results showed that 85% of the respondents are male household heads who possess a very low level of education. However, they have large family size (six, on average) and rich farming experience (23 years, on average). It is widely acknowledged that family size and composition affect the amount of labor available for farm, off-farm and household activities. It also determines the demand for food. Similarly, more experienced farmers are found to be able to identify soil erosion problems better than less experienced farmers (Shiferaw 2008).
Table 2
Independent variables and descriptive statistics

| Variables                              | Mean   | Standard deviation |
|----------------------------------------|--------|--------------------|
| Sex (male) a                           | 85.00  |                    |
| Education level (years)                | 2.10   | 2.70               |
| Farming experience (years)             | 23.48  | 12.30              |
| Family size (number)                   | 5.90   | 2.10               |
| Economically active household members (number) | 2.37   | 0.10               |
| Area of the plot (ha)                  | 0.44   | 0.17               |
| Slope of the plot a                    |        |                    |
| Flat/gentle                            | 15.70  |                    |
| Medium                                 | 39.80  |                    |
| Steep                                  | 44.50  |                    |
| Distance of the plot from dwelling a   |        |                    |
| < 5 min                                 | 14.10  |                    |
| 5-10 min                               | 39.50  |                    |
| 10-20 min                              | 31.00  |                    |
| > 20 min                               | 15.40  |                    |
| Security of tenure (yes) a             | 90.80  |                    |
| Livestock holding (TLU) a              |        |                    |
| Less than 1                            | 7.50   |                    |
| 1-3                                    | 43.30  |                    |
| More than 3                            | 49.20  |                    |
| Off-farm activities a                  |        |                    |
| Never engaged                          | 65.80  |                    |
| Petty trade                            | 29.20  |                    |
| Wage labor                             | 5.00   |                    |
| Extension contact a                    |        |                    |
| Once/month                             | 42.50  |                    |
| Twice/month                            | 40.00  |                    |
| > 2/month                              | 17.50  |                    |

a per cent (proportions)

Source

Own analysis from survey data, 2017.

Looking at the economic variables, the data shows that only 34.2% of the sample households are engaged in off-farm/non-farm activities. Off-farm/non-farm activities have served farmers in the study area as sources of additional income to purchase food crops mainly and other non-food commodities. Involvement in petty trading and wage labor accounted for 29.2 and 5.0% of off-farm employment opportunities, respectively. Majority of the respondents (about 93%) possess livestock (TLU). Number of economically active household members who live and work for the household also determines the labor available in the household which in turn may determine the type of SWC measures used by the farm households. Households with more labors may decide to use conservation measures which require more labor force but effective and efficient.

Concerning biophysical characteristics, it is undisputable that SWC measures may take some area
that would have been used for cultivation (growing) of crops. Hence, it is assumed that farmers with larger farm plot area are more likely to use improved SWC measures to reduce soil erosion and conserve water in their farm plots than farmers with small farm plots (Semgalawe 1998). The survey result shows that the average size of farm plot for the sample households is 0.43 ha. This indicates that there is a serious shortage of farmland in the study area. Slope is one of the farm attributes that can aggravate land degradation in general and soil erosion in particular. Farmers who have farms in areas which are more prone to soil erosion are expected to experience more soil erosion and therefore recognize the impact of topsoil loss more easily than farmers with farms located on flat areas. In this study, 15.7%, 39.8%, and 44.5% plots were located on flat, medium and very steep slopes, respectively. It is expected, thus, that the steeper the slope of the farmland, the higher the probability of the farmers to adopt improved SWC technologies. Distance between farm plots and a homestead is important in which a considerable amount of time can be lost in walking long distances. In addition, it is easier for farmers to care their farm and to construct and maintain structural SWC practices and for manure application on the fields near their homesteads than fields that are far away. As it is indicated Table 2, about 15% of the farms are located more than 20 minutes away from homestead. During the FGDs, it was indicated that leaving crop residues on the cultivation field enhances soil fertility. However, when the land is located far away from homestead, other people may take the residues for home use (fuel energy), for animal feed, for fencing and even for sell. Thus, if the farm field is located near the farmhouse, it becomes easier to be managed and receives better attention.

The issue of tenure security is among the institutional variables considered in this study. Farmers in the study area have four major sources of land. These are 1) inheritance from family, 2) receiving from kebeles, 3) sharecropping, and 4) renting system. The survey result revealed that more than 90% of the respondents feel secure about their land holding. Further, it was found that 76% of the respondents believe that land belongs to the government; 89% expect to use the land throughout their lifetime; 94% think that they have the right to inherit the land to their children; and 93% believe that they can decide to invest on SWC. Land tenure has important implications for agricultural
development in general and SWC in particular (Woldeamlak 2006). Land tenure arrangements in rural Ethiopia have undergone frequent changes since the 1974 revolution. The land reform proclamation, “Land-to-the tiller”, which proclaimed that land cannot be sold or mortgaged is one in the Dergue regime. Then, in 1995 a new constitution has been enacted. In this proclamation farmers have been given the right to use their land indefinitely, but selling or mortgaging of land is still prohibited (Kebede 2006). It is generally concluded that a more secure tenure system provides the necessary incentives for farmers to decide on adoption of SWC measures on their farm plots (Tesfaye 2011).

The other institutional characteristics is contact with Development Agents (DAs). Having good relationship with DAs helps farmers to be aware of improved SWC practices in reducing hazard associated with soil erosion. The DAs can provide technical information and advice as well as training on improved SWC practices. In the survey, we found that about 43% of the farmers have interacted with DAs at least once a month.

**Farmers’ perception on soil erosion**

During the survey, farmers in the sample were asked to classify their farm plots, depending on the perception of degree of erosion problem (extent/severity), as low, medium and high. Thus, according to farmers’ perception, 12.5%, 41.7%, and 45.8% of the total farm plots were affected by low, medium and high erosion, respectively (Table 3). Soil erosion is a naturally occurring process on all land. The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year in the study area. The role of water in eroding the land is very high during rainy season. On the other hand, wind causes erosion during dry/windy season. Among the interviewed farmers, about 36% and 30% ranked cultivation of steep slopes and poor agricultural practices as the main causes of land degradation, respectively (Table 3).

| Perception of soil erosion severity/extent | Per cent |
|-------------------------------------------|----------|
| Low                                       | 12.50    |
| Medium                                   | 41.70    |
| High                                     | 45.80    |

| Major causes of soil erosion              | Per cent |
|-------------------------------------------|----------|
| Cultivation of steep slopes               | 35.5     |
| Poor agricultural practices               | 29.5     |
| Heavy rainfall                            | 20.5     |
| Ceaseless cultivation                      | 14.5     |

*Source: Own analysis from survey data, 2017.*
Farmers’ perception on structural SWC measures

The variables considered here are related to respondents’ perception towards risks and comparative advantages of SWC technologies. These variables are important factors in influencing households’ participation in improved/new SWC practices. The relative superiority of the technologies in terms of their advantages enable farmers to have favorable perception about the technologies, which in turn enhances decision in favor of adoption of the technologies. In order to get essential information and insight concerning farmers’ decision on adoption of improved SWC practices, looking at their perception on each practice to which they are employing is quite important. Hence, knowledge of farmers’ evaluative perception on technology attributes in the study area is an appropriate issue. In this study, a five-point Likert scale was used for this purpose and the result is depicted in Table 4.

Table 4
Distribution of farmers’ perception on structural SWC measures (5-point Likert-scale).

| Perception Statement                                      | 5-Point Likert Scale a | Chi-square |
|-----------------------------------------------------------|------------------------|------------|
| 1. Traditional structural SWC measures are more flexible | 87.5                   | 6.89       |
| 2. Improved soil bund increases the quality of soil fertility | 30.0                   | 72.05***   |
| 3. Improved stone bund needs more use of inputs          | 39.1                   | 16.91**    |
| 4. Improved check dam requires frequent maintenance      | 29.2                   | 10.50      |
| 5. Improved soil bunds are possible to practice on small farm plots | 1.6                    | 17.50      |

| SA = Strongly Agree; A = Agree; NO = No Opinion; D = Disagree; SD = Strongly Disagree
| ***,**, significant at 1% and 5% probability level, respectively.

Source

Own analysis from survey data, 2017.

As indicated in Table 4, almost all the respondents proclaimed that traditional structural SWC measures are more flexible. On the other hand, more than 70% of the farmers stated that improved soil bund increases soil fertility; more than 90% of the sampled households agreed that improved stone bunds need more inputs/materials; and, more than 90% of the respondents stated that
improved check dams require frequent maintenance.

Factors affecting use of improved structural SWC measures

The results of Multinomial Logit (MNL) analysis conducted to assess factors affecting smallholder farmers’ adoption of improved structural SWC measures is given in Table 5. The dependent variable, adoption of improved SWC measures, has four categories: traditional or no adoption (base category), improved soil bund, improved stone bund, and improved check dam. The MNL model was run using 248 plots: traditional structures (113), improved soil bund (92), improved stone bund (25), and improved check dam (18). There are 12 explanatory variables that entered into the MNL model.

As can be seen in the lower part of Table 5, the MNL model is significant with a reasonable explanatory ability. Overall, the econometric analysis indicated that education, farming experience, number of economically active household members, extension contact, plot area, and plot distance from dwelling were found to affect farmer’s decision on the use of improved structural SWC measures significantly. However, these variables affect the use of one, two or all of the conservation structures at different sign, magnitude and significance level. In what follows, we discuss these significant predictors of farmers’ use of improved structural SWC measures in the study area.
Table 5
Multinomial Logit (MNL) model estimation results.

| Variable                  | Improved Soil Bund | Marginal effect | Improved Stone Bund | Marginal effect | Improved Check Dam | Marginal effect |
|---------------------------|--------------------|-----------------|---------------------|-----------------|--------------------|-----------------|
|                           | Coef. (Std. Err.)  |                  | Coef. (Std. Err.)  |                  | Coef. (Std. Err.)  |                  |
| Sex of household head     | 0.45 (0.72)        | 0.0221           | 0.68 (0.45)         | 0.0221           | 0.05 (0.08)        | 0.0036           |
| Education level           | 2.64 (0.67)        | 0.0055 ***       | 2.60 (0.58)         | 0.003 ***        | 2.47 (0.56)        | 0.006 ***        |
| Farming experience        | 0.29 (0.11)        | 0.006 ***        | 0.30 (0.15)         | 0.001 **         | 0.24 (0.15)        | 0.002 *          |
| Security of land tenure   | 0.37 (0.88)        | 0.008            | 0.83 (0.80)         | 0.0162           | 0.10 (0.70)        | 0.0024           |
| Perception of soil erosion| 1.54 (1.26)        | 0.003            | 0.86 (1.41)         | 0.0129           | 1.68 (1.43)        | 0.037            |
| Extension contact         | 1.93 (0.94)        | 0.0052 **        | 1.22 (0.80)         | 0.0194           | 0.01 (0.70)        | 0.0002           |
| Livestock holding         | -0.37 (0.32)       | -0.0007          | -0.31 (0.30)        | -0.0049          | -0.27 (0.23)       | -0.0062          |
| Plot area                 | 1.40 (0.52)        | 0.0028 ***       | 1.22 (0.59)         | 0.0184 **        | 1.92 (0.53)        | 0.0426 ***       |
| Plot distance             | -0.35 (0.37)       | -0.0007          | -1.22 (0.59)        | -0.0001 **       | -0.73 (0.40)       | -0.0165 *        |
| Slope of the plot         | 2.11 (1.30)        | 0.0043           | 1.43 (1.43)         | 0.0215           | -4.44 (2.44)       | -0.0000          |
| Off-farm activities       | -3.67 (2.31)       | 0.361            | -3.83 (2.40)        | 0.070            | 0.24 (0.26)        | 0.0055           |
| Number of economically active household members | 0.62 (0.38) | 0.0013 * | 0.09 (0.33) | 0.0013 | 2.43 (1.49) | 0.054 |
| Constant                  | -4.75 (3.73)       | -6.85 (3.28)     | -5.08 (3.00)        | - | - |
| Observations              | 248                | 248              | 248                 |                 |                   |                 |
| Log likelihood            | 118.18             | 118.18           | 118.18              |                 |                   |                 |
| Chi squared               | 134.97 ***         | 134.97 ***       | 134.97 ***          |                 |                   |                 |
| Pseudo R²                 | 0.36               | 0.36             | 0.36                |                 |                   |                 |

*, **, *** significant at p < 0.1, p < 0.05, and p < 0.01 probability level, respectively.

Dependent variable = existence of improved structural SWC structure on the farm plot

Source
Own analysis from survey data, 2017.

Educational level of household head

Education level is positively and highly significantly associated with the use of improved soil bund, stone bund and check dam. More precisely, a one-year increase in education will increase the probability of a household to use improved soil bund, stone bund and check dam by 0.55%, 0.3%, and 0.6%, respectively. This implies that household heads with relatively better formal education are more likely to use appropriate improved structural SWC practices and they are also able to anticipate the consequences of soil erosion than non-educated farmers. In addition, they have better understanding of their environment and risks associated with cultivation of marginal lands. Our result is in line with empirical evidence obtained from different parts of the country (e.g., Anley et al. 2007; Tizale 2007).
**Farming experience**

Farming experience is also positively and significantly related to the adoption of improved structural SWC measures in the study area. The result indicates that experienced farmers tend to use improved conservation strategies than non-experienced farmers. In relation to this result, Shiferaw *et al.* (2008) asserted that experienced farmers are capable of detecting soil erosion problems more than non-experienced farmers. Similarly, Fekadu *et al.* (2013) pointed out that those farmers who have better farm experience have high chance of being participant. As observed from the result, a one-year increase in farming experience increases the probability of farmers’ adoption of improved soil bund, stone bund and check dam conservation by 0.6%, 0.1% and 0.2%, respectively.

**Extension contact**

Extension service on SWC practices was found to have a positive effect on adopting improved soil bund. However, it did not affect the adoption of improved stone bund or check dams. Farmers who receive extension message on SWC from development agents will be more encouraged to use improved SWC practice on their farm plots. Similarly, Yitayal *et al.* (2006) and Tizale (2007) reported that households with access to extension services and information have better understanding of land degradation problem and soil conservation practices and hence may perceive SWC practices to be profitable. As observed from the model result, as farmers get extension message/contents on SWC practices, the probability of using improved soil bund increases by 0.52%.

**Plot area**

The MNL model results indicate that plot area has a positive and significant effect on the likelihood of adopting all types of improved structural SWC structures. This is because farmers with larger farm plot are more likely to be able and willing to use improved SWC measures to reduce land degradation problems in plots located on sloppy areas. This result is in line with empirical studies that have shown a positive and significant effect of area of a plot on the decision to use conservation measures (for instance, Amsalu and De Graaff 2007; Kassa *et al.* 2013). Hence, plot size promotes conservation. The result shows that as plot area increases by a hectare, the probability of deciding to use improved soil bund, improved stone bund and improved check dam increases by 0.28%, 1.84% and 4.26%,
respectively.

**Distance of the plot from dwelling**

Distance of the plot from the dwelling is related negatively with improved check dam and improved stone bund. The result from the model output indicates as the distance of the plot from dwelling of the household increases by one kilometer, the probability of using improved check dam and improved stone bund decreases by 1.65% and 1%, respectively. This result in line with the findings of Derajew et al. (2013).

**Number of economically active household members**

SWC activities demand labor which is a critical problem in a peak period of production and livestock rearing. In this study, number of economically active household members who actively participate in improved structural SWC relates positively and significantly with adoption of improved soil bund. The model result indicates that as the number of economically active household members increases by one person, the probability of using improved soil bund increases by 0.13%. We did not find any significant relationship between this variable and adoption of the other improved structural SWC measures. This result is in line with the findings of Tadesse and Belay (2004).

**Conclusion And Policy Implications**

Farmers’ conservation decisions are shaped by several factors. In order to understand the factors affecting adoption of improved structural SWC measures at smallholder farm level, this study was conducted in Haramaya district of eastern Ethiopia using a randomly sampled 248 plots. Quantitative and qualitative data were collected from primary and secondary sources. The results of the MNL analysis indicate that education, farming experience, plot area, number of economically active household members, and extension contact were found to affect the use of improved structural SWC strategy on farm plot significantly. Hence, development policy and program intervention designed to enhance agricultural productivity through promoting structural SWC measures in the study area need to take into account these most important variables with respect to the type of innovation and farmers’ preference.

The findings of this study show the importance of education among households’ characteristics.
Therefore, stakeholders who work on SWC programs and projects should use those educated farmers as models to others in order to demonstrate the importance of improved SWC measures. Likewise, agricultural extension services in the study area have duration of more than three decades. However, the findings of this study indicate that the contribution of extension service to the adoption of improved conservation technologies by farmers is not satisfactory. Thus, there is a need to emphasize conservation in the existing extension system in order to enhance the use of improved conservation measures by farmers.

The results of the study indicate the area of plot increase the probability of using improved structural SWC measures. Thus, programs working on SWC should focus on farmers having relatively larger farm plots as point of entry to acquaint the practice more by small farm owners. The study also revealed that number of economically active household members has a significant and positive correlation with improved soil bund conservation strategy. Therefore, extension planners should give attention to proper management of labor in order to attain SWC goal.

Distance of the plot from the household dwelling also shows significant and negative correlation with improved check dam and improved stone bund conservation strategies. Therefore, extension planners and implementers should consider the issue while program planning and implementation to realize the required result. Finally, the result of the study indicates the farming experience of the household head affecting the use of improved SWC measures. Thus, the district bureau of agriculture and natural resources and other relevant stakeholders should focus on farmers having relatively larger farming experience as point of entry in order to scale-up the practices and benefit younger and relatively less experienced farmers through a trickle-down effect.

List Of Abbreviations
CC Contingency Coefficient
DAs Development Agents
FGDs Focused Group Discussions
GoE Government of Ethiopia
HDARDO Haramaya District Agriculture Office
HDFEDO Haramaya District Finance and Economic Development Office

MNL Multinomial Logit

PSNP Productive Safety Net Program

SSA Sub-Saharan Africa

SWC Soil and Water Conservation

TLU Tropical Livestock Unit

TOL Tolerance Level

VIF Variance Inflation Factor

Declarations

*Ethics approval and consent to participate*

Not applicable.

*Consent for publication*

Not applicable.

*Availability of data and materials*

The data that support the findings of this study can be obtained from the corresponding author up on request.

*Competing interests*

The authors declare that they have no competing interests.

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*Authors’ contributions*

*MGW* designed the study, analyzed the data and wrote the paper. *ENO* supervised data collection and analyzed qualitative data. *EE* also contributed in the design, implementation and analysis of the research. *EE* designed the questionnaire and helped in data collection. *MGW, ENO and EE* designed the conceptual ideas of study and its implementation. *EE* collected and analyzed data. All authors
read and approved the final manuscript.

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