Innovations

Farmers' Willingness to Participate in Government-Led Soil and Water Conservation Campaign Programsand its Determinants in the Damota Area

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Abstract
Soil and water conservation (SWC) measures are considered to have a significant role in reducing soil erosion and the rehabilitation of degraded landscapes. As a result, the local government of Damota area has invested several resources. Nevertheless, adoption of introduced SWC measures by the farmers remains low. This study aimed to assess farmers' willingness to participate in the government-led SWC campaign program and the major determinant factors affecting the adoption of introduced SWC measures among farmers. A multi-stage sampling procedure was used to select 378 households (209 adopters and 169 non-adopters). Survey questionnaires, interviews, and field observations were used to collect the data. We used a multinomial logistic regression model to analyze the data. The results showed that although the government-led SWC campaign-based mass mobilization remains an indispensable approach to participating smallholder farmers, soil erosion still remained a pressing environmental problem in the area. Despite the necessity of the program, the majority of smallholder farmers prefer the implementation of indigenous soil and water conservation measures to the introduced measures. This is because farmers were not motivated by the program as it fails to incorporate local knowledge, priorities, and insights of farmers in local planning and implementation. Education, farm size, family size, livestock ownership, contact with extension workers, farming experiences, and tenure security have significant and positive relations with the adoption of introduced SWC measures. Hence, farmers' participation in SWC works need to be sustainable, and participatory and should be targeted toward local knowledge and insight of local farmers.

Key words: 1.*Adoption, 2.Campaign, 3.Introduced, 4.Multinomial logistic regression, 5.Soil and water conservation*

1. Introduction

Land degradation threatens agricultural productivity and contributes immensely to food insecurity and poverty (Shibru, 2010; Silesh et al., 2019). It has diminished the productive potential of the land (Haregeweyn et al., 2012). The extent of the problem is highly significant, particularly in the highland partsand the rural areas of developing countries, and the impacts are more severe (KiruiandMirzabaev, 2016; Silesh etal., 2019). In Ethiopia, the majority of the population lives in highlands where land is continually cultivated (Bewuket, 2009). As a result, the area is highly prone to water-induced soil erosion (Daniel andMulugeta, 2017; MihiretuandYimer, 2018). The problem is aggravated by natural events and anthropogenic factors such as land cover degradation, steep slope cultivation, agricultural intensification, population pressure, and inappropriate farming practices (Awulachew, 2010;Adimassu et al., 2014). Its effects on soil loss and land resource damage have been very high. For instance, the highlands of Ethiopiaare estimated to lose 2 billiontons of soil, of which 50% is from cultivated land, and the majority of the rural livelihood (66%) has been damaged by soil loss due to soil erosion (Hurni et al., 2010; Ajayi et al., 2012; Hurni et al., 2015).

In response to curbing soil erosion problems, the government of Ethiopia in collaboration with the local community and donorsorganizations has invested in SWC measures throughout the country(Kato et al., 2011; Adimassu et al., 2014). The initial effort of the program started in mid-1970 (Shimelis, 2012), to reduce soil erosion and land degradation, regenerate soil fertility, restore/rehabilitation of the degraded land, limit further land degradation, and intensify agricultural productivity (Mekuria et al., 2007).The effortmade during 1970-1980s were mainly centeredto solve the social aspect of the people in drought-affected areas of northeastern (Wollo area) and southeastern (Harrerighe areas) but little considerationas given to sustainable natural resource management and livelihood sustainabilityparticularly in the productive highpotential highlands (Haregeweyn et al., 2015; Mekuriaw et al., 2018).

Due to increased soil erosion,the decline in soil fertility, and the associated loss of productivity continued drastically, the government and donors designed new strategies to encourage effective technologies for the sustainable rural livelihoods (Haregeweyn et al., 2015).As a result, the current government has been encouraging continuous efforts on mechanical, agronomic, and biological SWC measuresat a micro- and macro watershed level(Silesh et al., 2019)via free community mass-mobilization for 30-60 daysper year (Assefa et al., 2018).

In spite of considerable efforts and community-mobilizations through government-led campaigns, only about 18% of the cultivated land has been treated with different soil and water conservation measures (Hurni et al., 2015). Hence,water-induced soil erosion remains the main challenge(Haregeweyn et al., 2015; MogesandBhat, 2020), and quantity of soil loss has been rapidly increasing (EPD, 2010). Besides,farmer-based sustainableadoption and implementation processes have not been sustainably used among local farmers (KirubelandGebreyesus, 2011; Asnake et al., 2018; Wordofa et al., 2020).

Several empirical studies have investigated factors determining the adoption andcontinued use of SWC measures in the Ethiopian context such as demographic, biophysical, socioeconomic, and institutional factors (Adimassu et al., 2014; Dagnew et al. 2015;Silesh et al., 2019). However, there was a disagreement of findings among the determinant variables reported so far (Bewuket, 2007; Teshome et al. 2013). Some argue demographic variables as negative determinants (Bewuket, 2007), while others emphasize socio-economic variables as negative and institutional variables as positive determinants for the large-scale adoption of SWC measures (Teshome et al., 2016).But in the southern highlands, including the districts of Damota(study area) local level determinants of Governmnet led community mass mobilization have not been sufficiently studied.

Similar to most of the highlands of Ethiopia, the districts of the Damota area have been experiencing high soil erosion. The area is characterized by high population density, high rainfall erosivity, and rugged topography, which is intensively cultivated for a long period. It has rugged mountains, hills with steep slopes, valleys, and flat to dissected plains, which results in poor soil fertility and high environmental degradation. Encroachment of settlement, inappropriate land utilization, land-use changes, and deforestation are among the couses that lead to severe soil erosion. Although continuous efforts and investments have been made through campaigns by the local government in SWC programs, the effects, continued uses of the SWC measures is very limited and the adoption level is varies among rural households. Despite these facts, site specific determinants of the adoption and continued use of different SWC measures received little research attention. Besides, most of the previous researchers focused on determinants to the combination of several SWC measures using binary logistic regression model. However, different SWC measures might have different adoption levels and preferencesby the community depending on the local conditions. The use of Multinomial logistic regression model can give better results concerning the determinants of individual SWC measures that are commonley practiced in the area. Therefore,this study aimed to explore farmers' willingness to participate in a government-led campaign program and explore determinant factors affecting the adoption of introduced SWC measures in the Damota area districts of the Wolaita zone of Southern Ethiopia.

2. Materials and Methods

2.1. The Study Area

Damota area (the study area) is located in the Wolaita zone, Southern Nation, Nationalities, and People Regional State. It comprises of Bolosso-Sore, Damot-Gale, and Soddo-Zuriya districts, centeringDamota Mountain (Figure 2), and is found 395 km south of Addis Ababa, the capital city of Ethiopia.

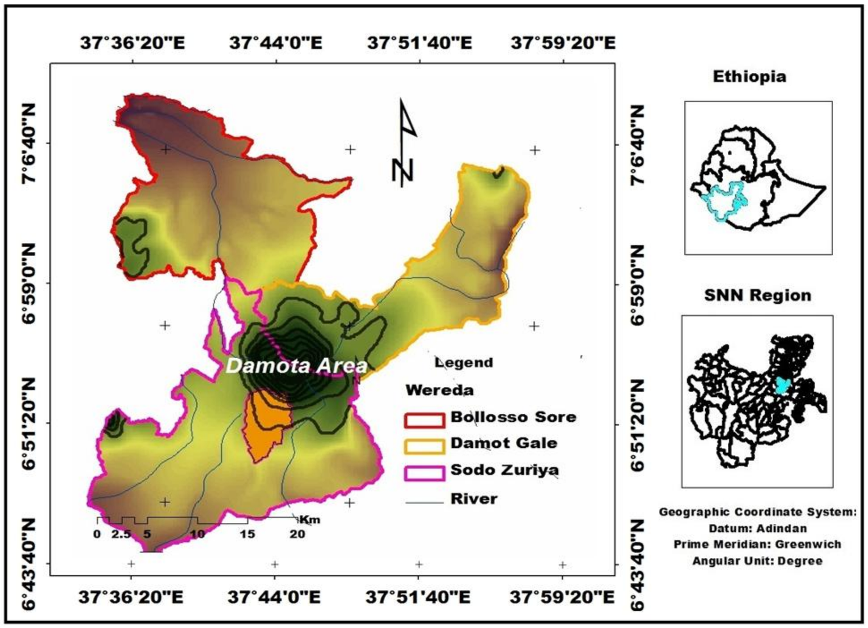

Figure2. Location map of Damota area (Source, EGSI 2020).

According to the agroclimatic classification system, the area is classified into highland (*Dega)* and midland (*Woina-Dega)* zones with an altitude ranging between 1480 and 2855 meters above sea level. The mean monthly minimum and maximum temperatures are 14 and 20 °C, respectively. The area receives an average annual rainfall of 1200 mm in a bimodal rainfall pattern. Cropland is the dominant landuse type in the study area followed by shrubwoodlands, grasslands, forestlands, barelands, and settlement. The districts are among the highly populated parts of the country in which the rural population density varied from 167 people per km^2 in the midlands to 746 people per km^2 in the highlands (CSA, 2015).

3.3 Research Design and Approach

A cross-sectional survey design was used.Before data collection, households were identified preliminary survey was made to idntify whether they are implementing SWC measures on their plots or not. Mixed research approach were followed.

2.2. **Sampling procedures and sample size**

Three districts were selected due to the severity of soil erosion and conservation practices. Then, three *Kebeles*, namely Wandara-Gale, Dalbo-wogene, and Gurumo-Koisha were purposively selected representing highland and midland agroecological zones and the severity of soil erosion. a total of 378 households were selected. In this regard, the formula of Kothari (2004) was used to determine sample size:

$$No= \frac{p(1-p)z^2}{e^2}$$

Where No = sample size, p= estimated proportions of respondents which is: 0.5, z= the number of standard errors corresponding to a 95% confidence interval which is 1.96, e= margin of error which is: 0.05 were selected

$No = \frac{0.5(1-0.5)1.96^2}{0.05^2} = 384.$

Therefore, using an infinite sample size determination formula, the total sample size included in the study was =384.

Finally, the finite size determination formula was used:

$n = \frac{no}{1+\frac{(n-1)}{N}}$; $n = \frac{384}{1+\frac{(384-1)}{25,086}} = 378.$

Table 1. Distribution of sampled household heads.

Districts	Sampled *Kebeles*	Total HHS	Samples		
			Adopters	Non-adopters	
Damot-Gale	Wandara-Gale	9,476	89	68	157
Soddo-Zuriya	Dalbo-Wogene	8,147	65	55	120
Bolosso-Sore	Gurumo –Koisha	7,463	55	46	101
Total		25086	209	169	378

Source: Own survey (2020).

2.3. **Data collection**

Qualitative and quantitative data were obtained from both primary and secondary sources. The primary data were collected from smallholder farmers, experts, and leaders. The major instruments employed to collect primary survey data include household survey questionnaires, focus group discussions (FGD), key informant interviews (KII), and on-site field observations.

2.4. Methods of data analysis

Both qualitative and quantitative method of analysis were used. Qualitative data obtained through focus group discussions, key informant interviews, discussions with farmers, and field observation results were supplemented with quantitative data and interpreted through narration. A multinomial logistic regression model was used to explore determinant factors for the adoption of introduced soil and water conservation measures.

2.5. 1.Multinomial logistic regression model specification

Multinomial logit model: this is an important regression model to examine the determinants of farmers' choices among the alternative soil and water conservation strategies. The assumption is that in a given period, smallholder farmers select among mutually exclusive soil and water conservation strategies that offer the maximum utility (Green, 2000)and specified as:

$U_{ij} = Z_{ij}\beta + \varepsilon_i$... (1)

If the sampled respondents make choice j in particular, then we consider that Uij is the maximum choice among the J utilities. Therefore, the numerical model is derived by the probability that choice j is made which is:

$prob(U_{ij} > U_{ik})$, for all other$k \neq j$.. (2)

Where U_{ij} the utility to the ith respondent from different SWC measures j.

$U_{ik}$is the utility to the ith respondent from variousSWC strategies K. If the farmer maximizes its utility defined over the adoption of soil and water conservation measures, then the respondent's choice is the implementation of specific soil and water conservation measures to choose the measures that maximize its utility (Geen, 2000). Thus, the ithrespondents' choice can be modeled as maximizing the expected utility by choosing the jth soil and water conservation measures among J specific soil and water conservation strategies, which is:

max_j = E (U_{ik}) =$f_j(x_i) + \varepsilon_{ij}$... (3)

In general, for the dependent variable with J categories, let the jth soil and water conservation strategy that the ith respondent chooses to maximize its utility take the value 1 if the ith respondent chooses jthspecific soil and water conservation measures and 0 otherwise. The probability that the respondent with characteristics “x” chooses soil and water conservation measures j, P_{ij} is modeled as:

$$P_{ij} = \frac{exp(X_i\beta_j)}{\sum_{i=0}^{j} exp(X_i\beta_j)}$$, J= (0.......3)... (4)

With the requirements that $\sum_{i=0}^{j} P_{ij} = 1$ for any i where P_{ij} =Probability representing the i^{th} respondent’s chance of falling into category j; X_i=Predictors of response probabilities and β_j=covariate effects specific to j^{th} response category with the first category as the reference. As pointed out by (Green, 2000), a convenient normalization that removes indeterminacy in the model is to assume that $\beta_j = 0$ (this arises because probabilities sum to 1, so only J parameter vectors are needed to determine the J+1 probabilities).

Hence,$exp(X_i\beta_j) = 1$, implying that the generalized Eq. (5) above is equivalent to:

$$pr\left(Y_i = {}^{j}/_{X_i}\right) = P_{ij} = \frac{exp(X_i\beta_j)}{\sum_{j=0}^{J} exp(X_i\beta_j)}$$, for j = (0, ⋯ J) and

$$pr\left(Y_i = {}^{1}/_{X_i}\right) P_{ij} = \frac{1}{1+\sum_{j=0}^{J} exp(X_i\beta_j)}$$ .... (5)

3. Results and Discussion

3.1. Determinants of farmers’ adoption of SWCmeasures: Multinomial model results

Fourteen variables expected to have a relationship with the adoption of soil bund, Fanyajuu, and stone bundconservation measures were designated and considered in the model (Table 3).To determine the problem of multicollinearity or relationship between the independent (explanatory) variables, the variance inflation factor (VIF) for continuous variables and the contingency coefficient for categorical variables were checked.In this regard, the tolerance value of all variables in the model (1-R^2)is between 0.1 and0.75and their VIF are also between 1 and 10, which showed the absence of multicollinearity. To test the whole significance of the model, likelihood ratio test statistics were used. The likelihood ratio test indicated that the considered model and the set of independent (explanatory) variables fit the data better than the model containing the constant only. This implies a goodassociationbetweenthe odds ratio (log of odds) and theprospect of the implementation of soil bund, Fanyajuu, and stone bundconservation measures and the independent variables included in the model, which jointly contributed significantly to the explanation of determinant factors. In the model, the overall probability test ratio statistics shown by the chi-square statistics are significant at 0.001, indicating theexplanatory power of the model.

3.1.1. Demographic Factors

The sex of households has a negative and significant influence on theimplementation of soil bunds and Fanyajuu at the 0.05 and 0.01 probability levels (Table 3). The negative relationship indicates as female farmers are less likely to be involved in the implementation of soil buds and Fanyajuu than malehouseholds. In this study, in femalehouseholds, other things constant would result in 0.056, 0.514, and 0.111 decreases in adopting soil bund, stone bund, and Fanyajuu conservation measures, respectively. This could be because female farmers do not cultivate their land by themselves unless they appoint male labor and they are highly likely to be involved in non-farm activities. As a result, they settled their land for males and were involved in non-farm activities such as preparing local drinks, working on spinning and poetry work, engaging in petty trading like grain and fruit trading, and selling firewood rather than farming activities and management measures. It was consistent with the earlier studies of Tenge et al. (2004), Lemani (2017), and Daniel andMulugeta (2017),which showed that male households are highly likely to implement modern agricultural production technologies than female households.

The age of rural farmers negatively and insignificantly influenced the implementation of soil bunds, stone bunds, and Fanyajuu. The negative relationship indicates that older households were less likely to implementsoil and water conservation measures than younger households. This result was in agreement with the work of Shiferaw et al. (2014) but in contrast with the findings of Damtew et al. (2015) and Berhanu et al. (2016) who reported that younger farmers do not expend more effort on the SWC practice than older farmers.

3.1.2. Socio-economic Factors

Implementation of soil bunds, stone bunds, and Fanyajuu conservation measures increased with increasing family sizes. It has a positive and significant association with the implementation of stone bunds and Fanyajuu and the association was significant at the 0.05 and 0.001 probability levels, respectively. This implies that the larger households had a better labor force to construct labor-intensive conservation measures than their counterparts. More specifically, the current estimation result showed that being other variables contestant, as the number of families in the households increases by one unit, the odds of a household's adoption of soil bunds, stone bunds, and Fanyajuu conservation measures increase by a factor of 1.10, 1.44 and 2.15 units, respectively. This result was consistent with the findings of Damtew et al. (2015),Berhanu et al. (2016), and Lemani (2017), which reported an increase in the adoption of conservation measures with a large numberof household members in a given family.

Farm sizesignificantly and positively affected the implementation of soil bunds, stone bunds, and Fanyajuu conservation measures at a 0.001 probability level (Table 3). This denotes that the farmers with large farmlands are high likely to implement soil bund, stone bund, and Fanyajuu conservation measures than those with smallfarmlands, and having large farmlandsprovides abetter chance to expand production. The results showed that with an increase of one unit of farmland size, the odds of household adoption of soil bund, stone bund, and Fanyajuu increased by a factor of 6.32,12.66, and 9.53 units, respectively. The finding was in agreement with the previous studies of Tadesse and Belay (2004), who stated that larger farmland associated with increased availability of money, increases the likelihood of investment in soil conservation measures.

The livestock holding positively and significantly influenced the implementation of soil bunds, Fanyajuu and stone bunds at the 0.05 and 0.001 probability levels, respectively (Table 3). This indicates that holdinglarger livestock creates abetter chance of obtaining income from livestock production, which also influences the implementation of soil and water conservation decisions. In this study, keeping other covariates constant, the households with a larger number of livestock would enhance the implementation of soil bund, stone bund and Fanyajuu conservation measures by 1.57, 1.27,and 1.57 units respectively. This result is in line with the finding of Kassa (2014) which specified a positive and significant influence of livestock holding on farmers' choice of the implementation of physical SWC measures.

3.1.3. Institutional Factors

Households with greater levels of education are highly likely to adopt soil bund and Fanyajuuconservation measures; because educated farmers can highly consider the consequences of soil erosion than non-educated farmers. Inthis regard, the results showed that one- extra year in education will increase the likelihood of farmers adopting soil bunds, stone bunds, and Fanyajuu by 1.32, 1.21, and 1.51 units, respectively, when other things are constant. This result was in agreement with the previous research findings of Erkie (2016) andLemani (2017) which elaborated that skilled farmers tend to better identify the threats of soil erosion and therefore tend to spend more effort on soil and water conservation measures.

The land tenure security has a positive and significant influence on the farmers' choice to adopt soil bunds, stone bunds, and Fanyajuu at 0.05 probability level (Table 1.3). The positive and significant relationship implies that land tenure security promotes incentives for the adoption of soil bund conservation measures. Keeping other covariates constant, the land tenure security considerably increases the probability of adoption of soil bunds, stone bunds, and Fanyajuu by about 2.28, 1.42, and 2.06 units, respectively. This result of the study was in agreement with the results of Belay andBewket (2013) who reported the association of tenure security with the implementation of SWC measures.

The households' interaction with the extension workers positively and significantly affected the adoption of soil bunds at the 0.01 probability level (Table 3). The positive and significant relationship indicates the farmers' good interaction and approach with the extension workers, promotedthe adoption of soil bund structures. In this regard, keeping other covariates at their constant, the households that interacted with the development extensions (Das) were highly likely to implement soil bunds, stone bunds, and Fanyajuu by 7.64, 2.30, and 0.66 units, respectively. This was in agreement with the studies of Damtew et al. (2015), Erkie (2016), Daniel and Mulugeta (2017), and Mohammed et al. (2018) but in contrast with the finding of Berhanu et al. (2016) who indicated thatcontact with extension services negatively influenced the adoption of SWC practice.

3.1.4. Farmland Related Factors

The gentle slope of farmlands resulted in negative and insignificant influence on the farmers' choice to adopt soil bunds, stone bunds, and Fanyajuu (Table 3). This indicates that farmers who cultivate a gently sloping field had no concern about the risk of soil loss. Keeping other covariates constant, the households with a gentle slope of farmland would decreasethe adoption of soil bunds, stone bunds, and Fanyajuu by a factor of 0.94, 0.89, and 0.45 units respectively. This finding was in agreement with the studies of Kassie et al. (2013) andWainaina et al. (2016) who indicated thatfarmers who are cultivatingsteep sloping lands perceived the threat of soil loss better than those farmers who cultivate a gentle field.

Distance of farmland from the home resulted in negative and significant influence on the farmers' choice to adopt soil bunds, stone bunds, and Fanyajuu at 0.001 probability level (Table 3). The result revealed thatthe distance of farmlands from the homestead is the main factor for the adoption of soil bund, stone bund, and Fanyajuu conservation practices; because those farmers far from the home are less likely to adopt soil and water conservation measures.Keeping other covariates constant, the households with a long-distance of farmlands would decrease the adoption of soil bund, stone bund, and Fanyajuu conservation measures by 0.009, 0.021, and 0.036 respectively. The finding of the study is similar toWagayehu (2003) andSenait (2005) who indicated that the closer the farmlands to the dwelling area, the closer supervision and attention, and the larger probability of farmers to the adoptionof soil and water conservation measures.

Farming experience of the households positively and significantly related to the adoption of soil bunds at the 0.01 probability level (Table 3). This indicates thatexperienced farmers have a habit of adopting soil bunds conservation measures than the nonexperienced farmers. In this study, keeping other covariates constant, aone-year increment infarming experience increased the farmers' implementation of soil bund, stone bund, and Fanyajuuconservation measures by 8.97, 3.05, and 3.75 units, respectively. Thisfindingwas in agreement with the studies of Shiferaw and Holden (2008) andFekadu et al. (2013) who reported that experienced farmers have more skill in perceiving soil erosion problems than non-experienced farmers.

Table 3. Multinomial regression model outputs of factors that affect the choice of soil management measures among farmers.

Independent Variables	**Soil bunds**		**Stone bunds**		**Fanyajuus**	
	Coeff.	Odds ratio (SE)	Coeff.	Odds ratio (SE)	Coeff	Odds ratio (SE)
Sex	-2.88**	0.056(1.03)	-0.665	0.514(0.89)	-2.201*	0.111(1.15)
Age	-0.08	0.091(0.05)	-0.044	0.095(0.58)	0.058	1.06(0.06)
Education	0.28**	1.32(0.12)	0.196	1.217(0.11)	0.413**	1.511(0.14)
Family size	0.1	1.10(0.15)	0.366*	1.44(0.16)	0.77***	2.159(0.20)
Farm size	1.84***	6.32(0.05)	2.55***	12.86(0.49)	2.254***	9.530(0.58)
Perception of erosion	1.28	3.62(0.85)	0.199	1.220(0.82)	0.38	1.462(0.87)
Extension Services	2.02**	7.64(0.84)	0.835	2.30(0.79)	-0.411	0.663(0.93)
Credit Access	0.073	1.075(0.90)	0.617	1.85(0.85)	-2.94**	0.052(0.94)
Farming experiences	2.19**	8.97(0.81)	1.117	3.055(0.75)	1.323	3.755(0.86)
Land slopes	-0.057	0.945(0.74)	-0.115	0.892(0.72)	-0.793	0.453(0.84)
Non-farm activities	-1.36	0.256(0.81)	0.57	1.76(0.77)	1.658*	5.249(0.86)
Distance of farmland	-4.72***	0.009(0.76)	-3.866***	0.021(0.74)	-3.328***	0.036(0.75)
Land tenure security	0.826*	2.28(0.82)	0.351	1.421(0.79)	0.727	2.069(0.87)
Number of liv. (TLU)	0.45***	1.57(0.1)	0.246*	1.279(0.10)	0.451***	1.570(0.11)

*Non-adopters were taken as a base case, Coeff = coefficients, SE =standard error), ***, ** and * indicate significant at 0.001, 0.01 and 0.05 probability levels, respectively. Number of observations= 378, Wald chi-square 657.056***, - 2 Log likelihood 296.247*

1. Conclusions

Soil and water management practices havebeen practiced through government-led free labormobilizations/campaign works in the area. The implemented interventions are appropriate for thereduction of erosion severity and ecological sustainability. However, the large-scale adoption of SWC measures by smallholder farmers remains low.This study is important because the widespreadadoption of SWC measures can only be achieved through participatory approaches that genuinely involve local farmers rather than directed by experts and leaders.There is community participation for 30-40 days per every year through the government-led campaign; however, their participation was through enforcement and depended onsafety net programs in which the outcome has been inefficient and unsustainable. On the other side, farmers of the area were unhappy to adoptthe introduced conservation measures;but they prefer theindigenousmeasures.This is mainly related to the direct benefits that they derive from indigenous activities such as planting trees and income-generating management of their ecology.Besides, education, farm size, family size, livestock ownership, contact with extension workers, farming experiences, and land tenure security were positive and significant ($p < 0.05$) predictors for the adoption of SWC measures by smallholder farmers.Thus, strong participatory approaches which incorporate all peoplehave to be designed based on the interest and priorities so as to promote large-scale adoption of soil and water conservation measures.Community priorities and alternative technologies must be addressed for large-scale adoption, and accordingly, itsimplementation and planning process should be based on local knowledge/ conditionsanda demand-driven integrated participatory approach. In general, particular attention should be given to the local institutions by developing effective integrated participatory programs that allow all farmers to bebenefited from the system by creating income-generating management on the adoption process.The local government and stakeholders should createawarenessthrough short and longtraining, andexperience sharing among farmers should be maintained/sustained.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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