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Farmers' Participation in Terracing as a Response to Land Degradation in Dejen Woreda, North-West Ethiopia

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Abstract
This study was carried out with the objective of examining rural households' participation in terracing activities as a response to the prevailing land degradation in Dejen woreda, north-west Ethiopia. Using simple random sampling technique, 360 households were selected. Qualitative and quantitative data emanated from both primary and secondary sources using questionnaire, interview, focus group discussion and observation. While qualitative data were analyzed using narrative and interpretative methods, quantitative data were analyzed using descriptive and inferential statistics. The study found out that most of the rural community is aware of the presence and severity of land degradation in the study area. However, farmers from kola agro-ecology are more aware of it than those from woina-dega areas. In terms of participation in terracing, it is only less than half of the participants who confirmed their engagement in terracing activities. While households from kola areas are relatively better engaged in terracing, the study found no significant difference between males and females in this regard. From the binary logistic regression result, it was evident that households' family size, access to credit service and participation in non-farm income generating activities have positive effect on participation in terracing. To the contrary, other variables included in the model (sex, age, level of education, agro-ecology, land holding size, number of plots and training on land management practices) have negatively and significantly contributed to participation in terracing.
Keywords: Land degradation, Land Management, Terracing, Participation, Dejen Woreda
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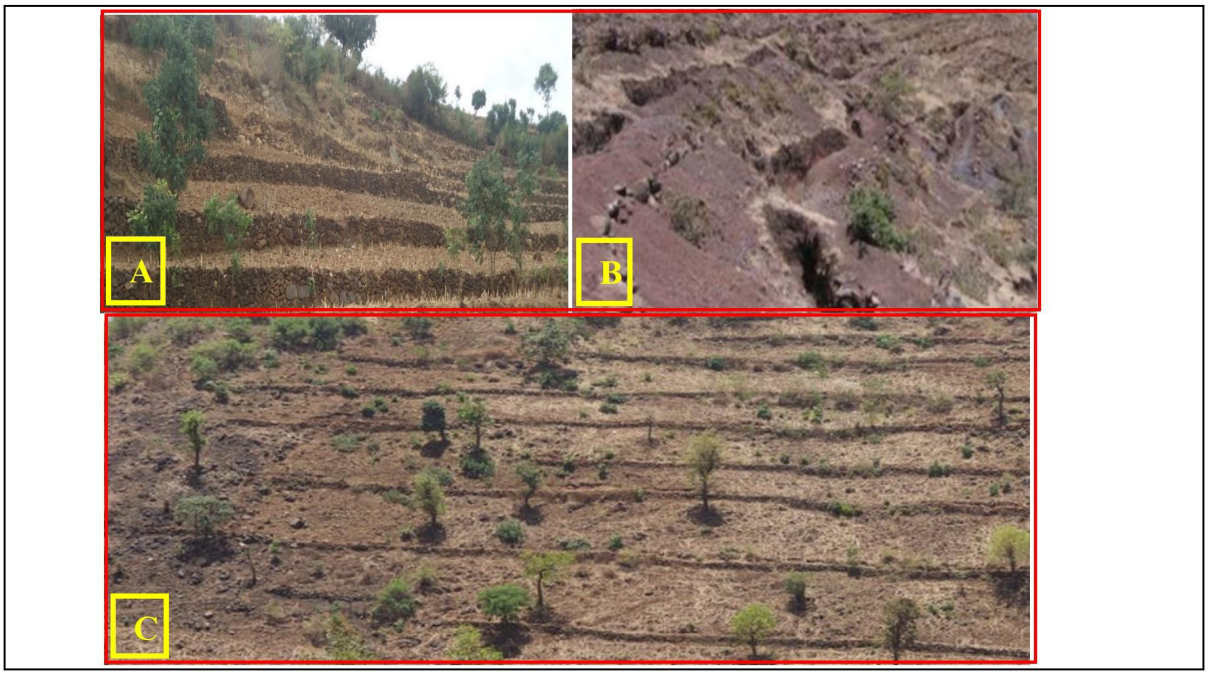
1. Introduction

Ethiopia is endowed with enormous natural resource potentials Since the country's economy hinges highly on agriculture, land is the most important resource. However, the country is still challenged with land degradation, the most critical environmental problem, which is manifested in the form of soil fertility loss, gully formation, soil erosion, and water scarcity (Yihenew & Tilahun, 2014). Land degradation includes all processes that reduce the capability of land resources, functions and services in ecosystems (Hurni *et al*. 2010). The problem is more critical in the north central highlands of Ethiopia where there is dense population and high concentration of livestock (Berry, 2003). Of all forms of land degradation, soil erosion by running water is the most critical and widespread, which is responsible for low agricultural productivity and food insecurity in Ethiopia (Woldeamlak, 2003) in general and in Amhara region in particular (Lakew et al. 2000). Land degradation in the form of soil erosion is not a new phenomenon in Ethiopia; it goes back to the beginning of agricultural practices (Berry, 2003).

Land degradation is a critical problem in Amhara region even more than other parts of Ethiopia. The combination of natural factors, long history of settlement, increasing population pressure, and age-old agricultural practice made the region more vulnerable for the risk of land degradation (Berhanu & Fayera, 2005). The rapidly growing population in the region has caused for the cultivation of hillsides, steeper slopes and ecologically fragile areas (Figure 1). Crop residues and cattle dung which were previously used by the community as important sources of organic fertilizer to the soil are now used either for household energy sources or for commercial markets (Lakew *et al*., 2000). The growing number of the rural population has severely destroyed available forests in search of farm land, construction material and fuel wood. In line with this, a study by ILRI (2000) revealed that about 20 thousand hectares of forest are annually cleared in Amhara region for construction, logging and fire wood purposes. Besides, free grazing and browsing too much livestock on forest and pasture lands (which are common practices in the region) are reported to have an exacerbating role for land degradation.

Figure 1: Steeply areas converted to farming land in Minj (A & B) and Gelgelie (B) kebeles



Source: Own Photo, 2021

A study by IFSP (2004) indicated that the region loses about 119 million ton of fertile soil every year due to water erosion which accounts for 70% of the soil loss in the country as a whole. As a result, about 10% of Amhara region experiences very high erosion rate (>200 t/ha per year); 29% is found to have high erosion rate (51.2 t/ha per year); 31% of the region receives moderate erosion rate (16.50 t/ha per year); and the remaining 30% experiences low erosion rate (<16 t/ha per year) (Lakew *et al*., 2000).

Even though sporadic efforts had been in place, a more consolidated and institution-driven land management practice has been implemented in Amhara region as well as throughout Ethiopia since the 1970's after the occurrence of the deadly famine episode in the northern part of Ethiopia (Zeleke *et al.,* 2006; Amsalu, 2006; Haregeweyn, et al., 2015). Since then, the region is implementing various land management practices in degraded areas through mass mobilization of the community and separately on household basis (Assefa, 2010). It comprises structural conservation measures (physical earth works like construction of terracing, cut off drain and bunds) followed by biological measures (plantation of grasses and forage plants to stabilize physical measures). In spite of all efforts made so far, land management in the region is reported not achieving its intended objectives (GIZ, 2015) for land degradation is still outweighing the management efforts.

Studies regarding determinants that affect farmers' decision to engage in terracing have diversified results in different parts of Ethiopia. While age is found to have a negative effect on farmers' decision to participate in terracing (Gebremichael, 2021; Miheretu & Yimer, 2017).; Teklewold and Köhlin, 2011), other studies conducted in the eastern highlands of Ethiopia by Mengistu (2012), in Beressa watershed of north Shewa by Aklilu (2006), in the Ethiopian highlands by Amsalu and Graff (2007) indicated a positive and significant association between them. Still another study (Berhan, 2016) has found no significant association between farmers age and participation in terracing. To the contrary, a number of studies (Gebremichael, 2021; Berhan,2016; Mengistu, 2012) conducted in various parts of Ethiopia showed the existence of insignificant association between farmers' sex and their participation in terracing. As per the results of these studies, being male or female has no significant difference in participating in terracing activities. The other key determining factor, education, has a diversified association with farmers' engagement in terracing. A number of studies (Mengistu, 2012; Amsalu and Graff, 2007; Asfaw & Admassie, 2004; Yirga, 2007; Miheretu & Yimer, 2017; Amsalu, 2006) conducted in different parts of Ethiopia found out a positive and significant association between level of education and farmers' decision to participate in terracing. On the other hand, while a study by Berhan (2016) indicated a positively significant but decreasing association between level of education and participation in terracing, another study by Gebremichael (2021) carried out in north-central highlands of Ethiopia revealed that the association between level of education and farmers' decision to participate in terracing is statistically insignificant.

In a number of literatures (Gebremedhin and Swinton, 2003; Miheretu & Yimer, 2017; Berhan, 2016; Pender and Gebremedhin, 2007), family size is reported to have a positive effect on farmers' decision to participate in terracing. To the contrary, a study by Bekele and Drake (2003) in the eastern highlands of Ethiopia

pointed out the existence of negatively significant association between number of family size in a household and farmers' decision to participate in terracing. however, Gebremichael (2021) in his study at the north-central highlands of Ethiopia found an insignificant association between family size and farmers' engagement in terracing. In the available literatures, landholding size has a mixed effect on farmers' decision to engage in terracing. While some studies (Bekele and Drake, 2003; Amsalu and De Graaff, 2007; Mango *et al.* 2017) showed the presence of positive and significant relation between land holding size and farmers' decision to engage in terracing, still other studies (Gebremichael, 2021; Berhan, 2016; Mengistu, 2012) found out an insignificant effect of landholding size on farmers decision to participate in terracing. The role of training to encourage farmers' decision to participate in terracing is also found significant in a number of studies (Miheretu & Yimer, 2017; Bekele and Drake, 2003; Dessie *et al.* 2012; Mengistu, 2012) though other studies by Berhan (2016) and Gebremichael (2021) revealed the existence of insignificant association between training and decision to participate in terracing. In various literatures, engagement in off-farm activities is reported to have effects on farmers' decision to participate in terracing. In this regard, while Gebremichael (2021) found a negatively significant association between farmers' engagement in off-farm livelihood opportunities and their decision to participate in terracing, another study by Mengistu (2012) pointed that participation in off-farm activities has a positive and significant effect on farmers' decision to engage in terracing.

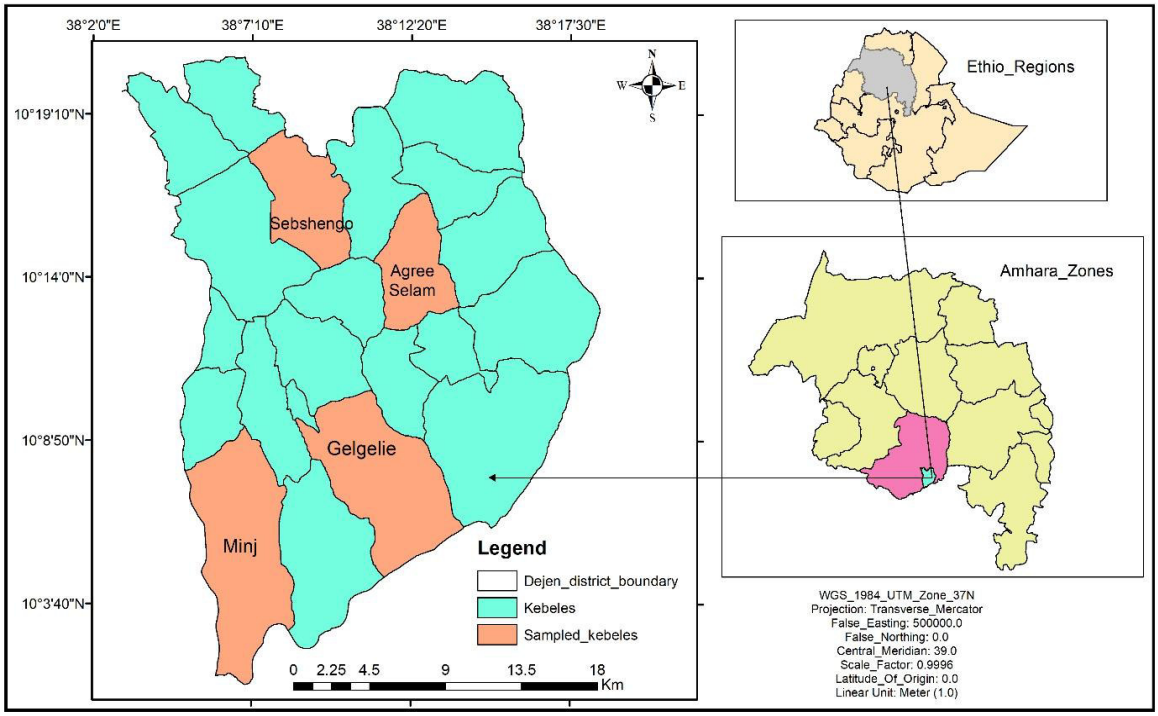
Even though the literature on the issue seems rich at the national level, such studies are scarce in East Gojjam zone and absent in the study woreda. This study is, therefore, aimed at examining the status of farmers' participation in terracing activities and major determinant factors that affect their decision to engage in terracing in Dejen woreda, East Gojjam zone of Amhara regional state, north-west Ethiopia.

2. Materials and Methods

2.1. Study Area Description

Dejen Woreda[1] is one of the 17 Woredas in East Gojjam administrative zone, Amhara Regional State. It is located in the North-Western part of Ethiopia, about 230 km away from Addis Ababa. Astronomically, Dejen Woreda lies between 10° 01' 00" N – 10° 21' 00" N latitude and 38° 03' 00" E – 38° 19' 30" E longitude. It is bordered by Awabel Woreda in the West; Debay-Tilatgin and Enemay Woredas in the North; Shebel-Berenta Woreda in the East and Oromia regional state in the South (Figure 1). Dejen Woreda covers a total surface area of about 570.9 km^2 which makes it relatively a smaller Woreda in East Gojjam administrative zone. The woreda is almost encircled by the deep gorge of Abay (Blue Nile) river and its tributaries such as Bechet and Suha. Administratively, Dejen Woreda is currently divided in to 19 rural and 2 urban kebeles (Figure 2).

Figure 2: Location Map of Dejen Woreda



Source: CSA, processed by GIS

[1] Woreda is lower administrative unit next to zone

Topographically, Dejen Woreda is characterized by varying relief with altitudes ranging from about 1000m at the Abay gorge to 2650m in the northern limit. As a result, there is a pronounced difference among the dega, woina-dega and kola [1] climatic zones. Most of the lands in the dega and woina-dega zones are flat plateaus. But areas lying in the kola climatic zone are characterized by extreme relief variations. Just like many other parts of Ethiopia, the climate of Dejen Woreda is greatly affected by altitude though other factors such as latitude and cloud cover do have their own influence. As a result of great variations in relief features, three vertically stratified temperature zones are found in the Woreda (kola, woina-dega and dega). While woina-dega climate covers 48% of the total area, kola and dega climates constitutes 39% & 13% of the woreda land mass. The average temperature and total annual rainfall of the district range between 20 and 24 °C and 800 and 1200 mm, respectively (Dejen woreda agriculture office, 2018).

2.2. Sample Size and Sampling Techniques

Generally, this study follows multi-stage sampling procedures. First, one woreda namely Dejen is purposively selected among 17 woredas in East Gojam zone administration. Then, Kebele administrations in the woreda are grouped in to three agro-ecological zones – *kola*, *woina-dega* and *dega*. Second, a total of four kebeles namely Minj, Gelgelie, Sebshengo and Hagereselam (the first 2 kebeles with kola and the next 2 kebeles with woina-dega climate) are selected as representatives of the lowland and highland parts of the woreda. Third, respondent households were selected from each sample kebele using probability sampling techniques.

Sample size determination formula developed by Cochran (1977) was used to estimate the sample size from the population and presented as follows.

i) For the infinite population, the formula use is;

$$n_0 = \frac{z^2 pq}{e^2}$$

Where, n_0 Is sample size, z is the selected value of desired confidence level, p is the estimated proportion of an attribute that is present in the population, q=1-p and e, the desired level of precision.

ii) From the finite population, the sample size is estimated as follows;

$$n = \frac{n_0}{1+\frac{(n_0-1)}{N}}$$

Here, n_0 is Cochran's sample size recommendation, N is the population size, and n is the new, adjusted sample size.

By using the above formula, the total number of respondents in this study was found to be 360 household heads. Proportional to their total household size, 86, 100, 90 and 84 household heads were selected as sample units from *Sebshengo, Agere-selam, Gelgelie* and *Minj* kebeles, respectively.

2.3. Data Collection and Analysis

Both primary and secondary data sources were used for this study. While secondary sources of data were extracted from policy documents, performance reports, and research papers through document reviewing, this research has also utilized questionnaire, interview, focus group discussion, and observation to collect primary data.

- *Survey Questionnaire* - to obtain relevant data from 360 household heads, structured survey questionnaire was prepared. In the survey questionnaire, carefully formulated items are included which can capture information from the sample households on socio-economic issues, land tenure security issues, and land management practices. The items of the questionnaire were mostly close-ended.
- *Key Informant Interview*: key informant interview was employed using semi-structured guiding questions. Key informants who have rich knowledge and expertise on the issue under investigation as well as institutions involved directly or indirectly in the land management process were considered as interviewees. Interview with key informants included 40 individuals: 4 development agents (1 from each sample kebele), 2 woreda Environmental Protection, Land Administration and Use Authority (EPLAUA) experts, 2 woreda agriculture and rural development experts, 8 Kebele Land Administration Committee (KLAC) members (2 from each sample kebele) and 24 household heads (6 from each sample kebele).
- *Focus Group Discussion (FGD):* Totally, 12 FGDs (3 in each sample kebele) were conducted with KLAC members and household heads in the sample kebeles. Each FGD had 5 - 8 participant members. Separate group discussions were also held with each sex (male and female) and age (youth and adult) categories so as to freely catch their feelings.
- *Observation:* In this study, observation was widely used to gather data about land management practices and triangulate data generated through the aforementioned tools and techniques.

[1] Kolla, Woina Dega and Dega agro-ecological zones lies between 500-1500, 1500-2300 and 2300-3200 mean above sea level, respectively (Hurni, 1998)

Data gathered from different sources using different tools have been analyzed using qualitative and quantitative methods. To analyze qualitative data, the research employed narrative analysis and interpretive analysis methods. On the other hand, both descriptive and inferential statistics were utilized to analyze quantitative data. While such descriptive statistics as mean, percentage, frequency and standard deviation were used, the study has also employed inferential statistics like chi-square test and binary logistic regressions. For quantitative data processing and analysis, Statistical Package for Social Sciences (SPSS) software version 25 was utilized.

2.4. Model specification

As mentioned in the method of data analysis section, this study employed binary logistic regression to evaluate households' participation in terracing practices. In the binary logistic regression model, farmers participation in terracing is measured as a dummy dependent variable (1=participant, 0=otherwise). The explanatory variables included in the model have varied natures which are mixtures of continuous, ordinal and categorical items (detailed description of the explanatory variables is presented in Table 1). In sum, the binary logistic regression model in this study is used to investigate the major factors that affect farmers' decision to participate or not participate in terracing practices in the study area. Hence, the binary logistic regression model is specified as follows:

$$In(Y) = In\left(\frac{Y}{1-Y}\right) = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \ldots\ldots\ldots + \beta nXn + \varepsilon$$

Where, Y = The predicted probability of the event (participation in terracing), which is coded with 1= participated; and 0=non-participants

$1 - Y$ = The predicted probability of the other decision (non-participants in terracing)

β_0 = Constant

βn = Coefficients of explanatory variables

Xn = Predictor variables

ε = Error term.

2.5. Working hypothesis and variable specification

Decisions to engage in long-term investments like terracing are made after considering various factors. Hence, it is hypothesized that farmers decision to implement terracing practices in the study area are affected by various socio-economic and physical factors. From literature and experience, the following working hypotheses were made for the relationship between the dependent variable and each explanatory variable pertaining to sample households. Details of variables that are included in the model are indicated in the following specification table (Table 1).

Table 1: Variables, Variable description and Unit of measurement.

Variables	Variable Description	Unit	Expected Signs
Dependent variable			
TERRACING	Participation in terracing	1=Participate, 0=Otherwise	+/-
Explanatory variables			
SEX	Sex of the household head	1=Male, 0=Otherwise	-
AGE	Age of the household head	Continuous	-
EDUC	Household head's level of education	1=Illiterate, 2=Read & Write, 3=Grade Level	+
FAM_SIZE	Family size of the household	Continuous	+
AG_ECO	Agro-ecology in which a household is found	1=Kola, 0=Woina-Dega	-
LANDSIZE	Land holding size of the household	Continuous	-
N_PLOTS	Number of plots owned by the household	Continuous	-
TRAINING	Training on land management practices	1=Yes, 0=Otherwise	+
ACCESS_CREDIT	Households Access to credit services	1=Yes, 0=Otherwise	+
PARTI_NONFARM	Household heads Participation in non-farm activities	1=Yes. 0=Otherwise	+

3. Result and Discussion

3.1. Descriptive results

As Table 2 clearly indicates, nearly equal number of samples were selected from kolla and woina-dega agro-ecological zones which indicate the presence of comparable number of households in kola and woina-dega zones. On the other hand, one can see a great disparity in the number of male and female participants in the study. This is, however, not surprising for the total number of female-headed households in the study area is far smaller in

number than the male-headed households. With regard to education, 31.9% of the participants are illiterate who are totally unable to read and write at least in their local language (Amharic). While 35.3% of the participants were able to read and write, the rest had learned some grade levels (32.8%).

Asked their exposure for trainings on land management practices, an overwhelming majority of the participants (75%) indicated that they have never got any training of such kind. This result shows the covered reality under chains of reports and media releases which propagate for the success of farmers' trainings about land management practices. To be successful in terracing, the most important method is working on farmers mind and bring meaningful change on farmers knowledge, attitude and skill towards terracing. In this regard, however, it was only 25% of the participants in this study who had adequate training.

The study has also examined sample households' access to credit service which has connections to their involvement in terracing. Unexpectedly, 92.2% of the participants witnessed that they have access to credit services mostly from non-formal financial institutions (table 2). Key informants and group discussants have confirmed that the major source of credit for most of the rural households in the study area is Amhara Credit and Saving Institution (ACSI). However, it is reported that getting credit from formal government and private banks is unlikely for the rural households since most of them are unable to fulfill the collateral criteria of these banks.

Table 2: Descriptive statistics of categorical variables

Category	Response	Frequency	Percent
Sex	Male	268	74.4
	Female	92	25.6
	Total	360	100.0
Level of education	Illiterate	115	31.9
	Read & write	127	35.3
	Grade level	118	32.8
	Total	360	100.0
Agro-ecology	Kolla	174	48.3
	Woina-dega	186	51.7
	Total	360	100.0
Credit service	Yes	332	92.2
	No	28	7.8
	Total	360	100.0
Have you got training?	Yes	90	25.0
	No	270	75.0
	Total	360	100.0
Participation in non-farm activities	Yes	247	68.6
	No	113	31.4
	Total	360	100.0

Source: Field survey, 2021

Engagement in non-farm income generating activities is another variable considered in this study which has relations with farmers decision to participate/not participate in terracing. As table *** depicts, 68.6% of the sample households have participated in any one type of non-farm income generating activity in their kebele or out of their residence site. From this, it is hardly impossible to deduce that most farmers use their time to earn incomes from non-farm activities rather than investing their time and energy on terracing to maximize crop productivity. However, about one-third (31.4%) of the total sample households were found fully engaged in farming activities including construction of terraces.

In the process of land management practices like terracing, age plays a significant role for its success. For this reason, age of sample household heads was considered as a variable in this study. Hence, there is a range of 56 years between the older and younger ages of the sample household heads. With this range, the average age of the participants is 47.18 years with a standard deviation of 12.22 years (Table 3). While the maximum family size of a household was 9 persons, the minimum is found to be 2 persons. However, the average family size of the sample households in the study area is 5.19 which is greater than the regional and national average of the rural population (4.5 and 5.07 respectively) (CSA, 2007). This indicates that the study area is one of the most densely populated woredas in Amhara region. Higher agricultural density has also its own implications on land degradation and land management practices such as terracing which is indicated in the next sections.

Table 3: Descriptive statistics of continuous variables

	Descriptive Statistics				
	N	Minimum	Maximum	Mean	Std. Deviation
Age of the household head	360	20	76	47.18	12.219
Household head's family size	360	2	9	5.19	1.336
Farmer's land holding size (ha)	360	.50	3.50	1.5515	.65676
Number of plots hold by the farmer	360	1	8	3.16	1.226
Valid N (listwise)	360				

Source: Field survey, 2021

In the life of the rural households, land holding size is the most basic and crucial issue as their livelihood is directly dependent on it. Because the agricultural population density is very high, the average size of land holding for the sample households is found to be only 1.55 hectares with a standard deviation of 0.66 hectares which is in fact a little beat larger than the national average (1.02 ha) (EEA, 2002). There is also a great disparity in land holding size among the sample households. While the largest holding size is 3.5 hectares, the smallest holding is found to be 0.5 hectares. This implies that there is unfair possession of farming land among the farming communities which might be linked with the land tenure system of the government. With the average holding size of about 1.55 hectares, the mean number of plots owned by the sample households reaches 3.16 which is about 0.49 hectares for each plot if divided equally. This clearly indicates the presence of land fragmentation in the study area which is one factor of accelerated land degradation. In addition, the number of plots hold by sample households ranges from 1 to 8 (Table 3).

3.2. Farmers perception towards land degradation and conservation practices

As one part of Amhara region, the study area (Dejen woreda) is also characterized by severe land degradation. More than 1/3 of the woreda's landmass is lying in the Abbay gorge and characterized by rugged topography which is suitable for soil erosion by running water. Moreover, both human and animal population are growing so rapidly and becoming beyond the carrying capacity of the woreda landmass. Literatures indicate that understanding farmers perceptions and knowledge about land degradation is fundamental to make wise decision about sustainable land management (Amsalu, 2006; Weldemariam et al., 2013). As the study result clearly shows, sample households in the study area seem to have very high understanding about the existence of land degradation in their respective localities. Over this issue, all sample households (360) replied that they are aware of the existence of land degradation in their kebeles.

Farmers' life is directly attached with their land. They cultivate it, produce from it and the produce sustains not only the life of the farmers but also the life of all of us. So, they are very much concerned about their land more than anyone else. As a first step, their knowledge about the existence of land degradation is excellent in the study area. However, farmers are required to know more about their land. To this end, sample households were also asked to tell us their understanding about the severity of land degradation in their localities. In this regard, more than half (55.3%) of the participants responded that the level of land degradation can be rated as "medium". However, a significant number (37.8%) of the respondents believe that there is high level of land degradation in their locality (Table 4).

Table 4: Farmers' perception on the extent of land degradation by Agro-ecology

How do you rate the extent or severity land degradation?		Agro-ecology		Total	X^2	df	P -value
		Kola	Woina-dega				
High	Count (%)	128 (35.6)	8 (2.2)	136 (37.8)			
Medium	Count (%)	39 (10.8)	160 (44.4)	199 (55.3)	184.100[a]	2	0.000
Low	Count (%)	7 (1.9)	18 (5.0)	25 (6.9)			

Source: Field survey, 2021

As it can be seen from the data, perception on the severity of land degradation differs between kola and woina-dega agro-ecologies. For instance, while 35.6% of the respondents from kola agro-ecology perceived the presence of high level of land degradation, those who perceived it at this level from woina-dega agro-ecoloy are only 2.2%. To the contrary, the majority of the respondents (44.4%) from woina-dega rated the existing land degradation level in their locality as 'medium" while only 10.8% participants from kola region have the same perception. The difference of respondents' perception on the severity of land degradation across agro-ecologies is also statistically significant with $X^2(2) = 184.1$, $p<0.001$ (Table 4).

Key informants and group discussants have also revealed that farmers in the study area have been engaged in various land management practices as a response to the prevailing land degradation. Although different types of structural, biological and agronomic land management practices have been implemented by the rural community, the most common intervention types are terraces such as stone bund, stone-faced soil bund and soil

bend. While stone bund and stone-faced soil bund are common types of terraces in the kola climatic zone, soil bund is widely used in the woina-dega areas. In the kola agro-ecological zone, stone bund and stone-faced soil bund are found to be the dominant land management practices for two main reasons. First, the topography is so rugged and steeply which oblige farmers to construct such slope reducing structures as terraces in order to check the physical removal of the soil by the running water. Secondly, there is excess stone of different size which is an important input to construct stone bunds and stone-faced soil bunds. On the other hand, soil bund is the dominant land management structure in the woina-dega agro-ecological zone where the topography is flat or nearly flat, stone is a scarce resource and the soil has developed very thick profile. Compared to kola areas, the extent of land degradation in woina-dega areas is small which can be treated with such small structures as soil bund.

As of the opinions of group discussants and key informants, terracing is the most commonly used land management practice in the study area. In the first place, it reduces slope gradient and runoff. Consequently, it reduces soil erosion and contributes for soil conservation. In line with this finding, various studies (FFTC, 2004 and GPA, 2004) found out that terracing has contributed for the reduction of runoff and soil loss. As a result of reduced erosion and enhanced conservation due to terracing, the soil becomes productive. In sum, they indicated that farmers usually strive for maximizing crop productivity by applying appropriate land management practices. However, participants could not cover their opinion about the negative sides of terraces. If, for example, terraces are poorly constructed, they have the potential to bring disastrous effects on the land itself and properties of the community up on failure. Besides, farmers claim that construction of terraces consumes a considerable amount of land so that it aggravates the scarcity of the farming land. In spite of these short comings, it is reported that farmers in the study area prefer to construct terrace as its advantages outweigh the possible shortcomings.

To evaluate the participation level of sample households, chi-square tests were run for terracing by sex and agro-ecology. As the data on table 5 clearly show, there seems great difference between respondents from kola and woina-dega agro-ecologies in terms of participation level on terracing. While the majority (79.3%) of the participants from kola zone were found engaged in terracing, the figure is very small (17.2%) for those from woina-dega agro-ecological zone. As group discussants pointed out, this disparity has a direct linkage with the severity level of land degradation in the two agro-ecological zones. Besides, it is only 47.2% of the participants who are found engaged in terracing activities from the total 360 sample households. The disparity of engagement in terracing activities between kola and woina-dega residents was also found statistically significant with X^2 (1) = 139.133, P=0.000.

Table 5: Sample household's level of engagement in terracing by agro-ecology and sex

Have you engaged in terracing?		Agro-ecology					P -value
		Kola	Woina-dega	Total	X^2	df	
Yes	Count (%)	138 (79.3)	32 (17.2)	170 (47.2)			
No	Count (%)	36 (20.7)	154 (82.8)	190 (52.8)	139.133[a]	1	0.000
Have you engaged in terracing?		Sex					P -value
		Male	Female	Total	X^2	df	
Yes	Count (%)	127 (47.4)	43 (46.7)	170 (47.2)			
No	Count (%)	141 (52.6)	49 (53.3)	190 (52.8)	0.012[a]	1	0.914

Source: Field survey, 2021

The study has also examined the participation level of male-headed and female-headed sample households in terracing practices. Even though it is less than half of their total number, about 47% of the participants from each sex group responded that they have engaged in terracing activities. From this result, it is possible to conclude that there is no difference between male-headed and female headed sample households towards engagement in terracing. The chi-square results also suggested that the level of participation in terracing by male-headed and female-headed sample households is almost similar with X^2 (1) = 0.012, P=0.914. On this issue, key informants explained that land degradation is impacting all farmers be it male-headed or female-headed. Therefore, both male and female households are trying all their best to reverse the devastative effect of land degradation through implementation of various land management practices like terracing.

3.3. Econometric results

A binary logistic regression was run in order to examine the effect of each explanatory variable (sex, age, family size, land holding size, number of plots, agro-ecology, level of education, training on LMP, access to credit

service and participation in non-farm activities) on the dependent variable (participation in terracing) in the model. Hence, the overall result showed that the regression model was statistically significant at X^2 (8) = 16.252, P=0.039 (Table 6). The model also explained 66.6% (Nagelkerke R^2) of the variance of participation in terracing and correctly classified 85.8% of cases. Moreover, the results of the binary logistic regression model revealed that most of the variables tested are found to have similar signs as hypothesized except for level of education and training.

Sex: It is found negatively correlated with participation in terracing and the result is statistically significant at 5% significance level (β = -1.344; P= 0.031). This implies that being female reduces the probability of participation in terracing activities. In other words, the odds ratio revealed that being female reduces households' participation in terracing by a factor of 0.261. This result is not surprising owing to females are physically weaker than males in such strong works as terrace construction. Moreover, it is reported that there is an odd belief in the study area that says constructing terraces is the role of males. As a result, female farmers do not have the know how to build terraces even if they wish to do so.

Table 6: Binary logistic regression for factors affecting farmers' decisions to apply terracing

Variables in the Equation

		B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Sex (1)	-1.344	.622	4.674	1	.031*	.261	.077	.882
	Age	-.033	.033	1.029	1	.310	.967	.907	1.032
	Level of education	-.699	.285	6.011	1	.014*	.497	.284	.869
	Family size	1.285	.325	15.609	1	.000**	3.616	1.911	6.841
	Agro-ecology (1)	-6.036	1.176	26.339	1	.000**	.002	.000	.024
	Land holding size (ha)	-1.185	.369	10.296	1	.001**	.306	.148	.631
	Number of plots	-1.031	.417	6.128	1	.013*	.357	.158	.807
	Training on LMP (1)	-4.378	1.043	17.601	1	.000**	.013	.002	.097
	Access to credit service (1)	.489	.595	.677	1	.411	1.631	.508	5.236
	Participation in non-farm activities (1)	.299	.361	.687	1	.407	1.348	.665	2.734
	Constant	-3.932	1.442	7.433	1	.006**	.020		

a. Variable(s) entered on step 1: Sex of the household head, Age of the household head, Household head's family size, Number of plots hold by the farmer, Agro-ecology, Level of education, Farmers' land holding size, Training on LMP, Access to credit services and Participation in non-farm activities.

*, ** means significant at 5% and 1% level, respectively

- Nagelkerke R^2 = 66.6%
- Overall percentage = 85.8%
- Chi-square (8) = 16.252, P=0.039

Source: Field survey, 2021

Age: In various studies, the role of age for engagement in terracing seems conflicting. For instance, studies by Amsalu (2006) and Beshir et al. (2012) state that farmers' engagement in terracing increases with age. Another study (Byron, Curtis and Mackay, 2005) found that age and participation in terracing have no association. Still a number of other studies indicated that participation in terracing decreases with increasing age of the farmers (Belachew et al., 2020; Daniel and Mulugeta, 2017; Mohammed et al., 2018; Teklewold and Köhlin 2011). They argue that farmers become physically weak when they get older and hence unable to engage in terracing. Moreover, the interest to participate in terracing decreases with increasing age of the farmer since terracing is a long-term investment out of which return can be got in the long run. In this study, however, the correlation between age and participation in terracing is found to be statistically insignificant at 5% level of significance (β = -0.033; P= 0.310) though they are negatively associated.

Level of Education: it is clear that education is a key to perform any activity. From this context, level of education was hypothesized in this study to have a positive correlation with participation in terracing. Various studies (Miheretu & Yimer, 2017; Asfaw & Admassie, 2004; Yirga, 2007; Tiwari et al., 2008) have also

indicated that education affects participation in terracing positively and significantly. However, the binary logistic regression result of this study showed that there is a negative and statistically significant correlation between level of education and participation in terracing at 5% level of significance (β =-0.699; P= 0.014). It indicates that a one unit increase in the education level of farmers leads to a decrease odd of participation in terracing by a factor of 0.497. This result seems odd which indicates that being an educated farmer reduces the probability of participating in terracing activities. Focus group discussants reasoned out that the relatively educated farmers do not have the plan to continue as farmers. Rather, they always wish and search for non-farm activities. As a result, they are not interested to engage in such long-term land management practices as terracing.

Family Size: terracing is by its nature a labor-intensive activity. Hence, it is expected and hypothesized in this study that participation in terracing increases with increasing number of family size in a household. As expected, the binary logistic regression revealed consistent result with what already hypothesized which indicated statistically positive correlation between family size and participation in terracing at 1% level of significance (β = 1.285; P= 0.000). This implies that having large family size contributes more labor for terracing. Being other variables constant, a one unit increase in the family size increases the probability of participation in terracing by odds ratio of 3.616. This result is also similar with the findings of Gebremedhin and Swinton (2003), Kassie et al. (2009) and Miheretu & Yimer (2017).

Agro-ecology: in the context of the study area, agro-ecology explains the nature of slope. While kola agro-ecology is characterized by steep slope, woina-dega areas are mainly flat. Farmers' decision to participate in terracing is mainly dependent on the nature of the slope which has a direct and positive connection with soil erosion by running water. As the binary logistic regression model indicates, being a residence in woina-dega areas decreases the probability of participating in terracing by the odds of .002. This result is also statistically significant at 1% significance level (β = -6.036; P= 0.000) and consistent with the findings of Kassie et al. (2009), Gebremedhin and Swinton (2003), Amsalu and De Graaff (2007), Asrat et al. (2004) and Wossen et al. (2015).

Land Size: the amount of land owned by a farmer is expected to have linkages with his decision to participate in terracing. As indicated in the descriptive statistics part, the average land holding size for the sample households is 1.55 hectare with a minimum and maximum holding of 0.5 and 3.5 hectares, respectively. The survey result has also showed that more than half of the participants' (about 60%) land size is less than the average holding size. At the beginning, it was hypothesized that farmers interest to participate in terracing activities decreases with increasing land size. As expected, the result of this study has found a negatively significant correlation between household's land size and participation in terracing. This result, however, contradicts with the findings of Aklilu & De Graaff (2007) and Wolka & Negash (2014) who found out a positive correlation between land size and participation in land management practices. As table 6 clearly shows, the binary logistic regression result indicated that household's probability of participating in terracing decreases with increasing land size at 1% significance level (β = -1.185; P= 0.001) which is similar with the hypothesis. The result of this study further shows that for every one unit increase in land size, the odds of participating in terracing for a household decreases by a factor of 0.306. This is so because it is farmers with small farm size who are much worrying about how to increase crop yield from their small land at least to be food self-sufficient. As a result, such farmers actively participate in land management practices like terracing more than the relatively land-rich farmers.

Number of plots: number of farm plots has its own effect on the successful utilization of one's time and energy. In the study area, the average number of plots owned by a household is 3.16 with a minimum and maximum number of plots 1 and 8, respectively. For a household, having a large number of plots means smaller farm size for each plot. Hence, the binary logistic regression result revealed that household's participation in terracing decreases with increasing number of plots. This result is also statistically significant at 5% level of significance (Table 6) which is consistent with the hypothesis. With every one unit increase in the number of plots, the likelihood of participating in terracing decreases with the odds of 0.357. While the negative correlation between number of plots and participation in terracing is supported by finding of Bekele and Drake (2003), other studies indicated a positive correlation between these variables (Kessler, 2006; Lal, 2001).

Training: training increases the knowledge, attitude and skill of the trainee. As a result, farmers who are trained on land management practices are expected to be more engaged in terracing than the non-trained. Having this notion, it was hypothesized that training increases farmers' participation in terracing activities. However, the finding of the study indicated that training and participation in terracing are negatively correlated. As the binary logistic regression result shows, households who have got training on land management practices are found less participated in terracing and the result is significant (P < 0.01). With every one additional training, households' likelihood to participate in terracing decreases with the odds of .013 and this result seems contradicting with the findings of other studies (Guteta and Abegaz, 2015a; Ketema and Bauer, 2012). The finding of this study seems odd but important for it helps to reconsider the training packages. Probably, the trainings might not be friendly with the local situations and hence not accepted by the community.

4. Conclusions

Land degradation is a crucial environmental problem directly affecting the livelihood of the rural community in Ethiopia. Amhara region in which this study has been carried out is one of the most severely affected by land degradation in the form of soil erosion. Aware of the threatening effect of land degradation, both the government and the rural community have been engaged in various land management practices since the 1970s. The management practices were, however, mainly focused on physical structures like terracing. Even if the physical structures implemented for the last few decades are criticized for not fully achieving the intended targets, it is an observable fact that these structures have protected the land from severe degradation. Specifically, this study has assessed the participation level of rural households in terracing activities and found their participation encouraging. However, various socio-economic and physical factors are found to have positive or negative effects on households' participation in terracing. Households' family size, access to credit service and participation in non-farm income generating activities are found to have positive correlation with participation in terracing. However, most variables included in the regression model (sex, age, level of education, agro-ecology, land holding size, number of plots and training on land management practices) are negatively associated with participation in terracing. Hence, both governmental and non-governmental organizations as well as the community at large should work in collaboration to minimize the effects of these negatively correlated factors and to change them in to positive energies if possible. For instance, training packages on terracing practices which incorporate the indigenous knowledge of the rural community and friendly with the local environment should be developed and put in to practice.

5. Conflicts of interest

The authors declare that they have no conflict of interest

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