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# Assessing Farmers' Perception towards the Effectiveness of Sustainable Land Management Practices in the Teleyayen Sub-Watershed of the Northeastern Highlands of Ethiopia

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## Abstract

The main objective of sustainable land management practice is to integrate people's coexistence with nature over the long-term, so that the provisioning of supporting services of ecosystems. Hence, understanding farmer's perception on the effectiveness of sustainable land management is vital. Data were collected using a survey questionnaire, focus group discussions, key informant interviews, and field observations. Independent-sample t-test, chi-square, percentage, mean and standard deviation were employed to analyze the data. The result of the study indicated that land tenure security problem (32.6%) is one of the major factors affecting farmers land management practices, followed by unaffordable price of fertilizer (27%), lack of assistance from development agents (15.8%), lack of credit access (14%), and negative perception towards land management practices (10.7%). Sixty-five percent of the focus group discussion participants also reported that the sustainable land management practices conducted in their area is not effective because of farmers' reluctance to participate in soil and water conservation practices, lack of incentives, poverty, and lack of awareness about the long-term benefits of such practices. Moreover, the chi-square results of gender of the household head (X2=8.716), land tenure security (X2=6.595), and educational status of the household head (X2=11.738), found to be significant in explaining the correlation between farmers' perception and the effectiveness of sustainable land management practices. Therefore, exploring farmers' perception towards the effectiveness of sustainable land management practices is helpful because it would improve the quality of the environment so that farmlands will remain productive for a long period of time.

**Keywords:** Ethiopia; Farmers' perception; Land degradation; Sustainable land management;

## Abbreviations

| | |
|---|---|
| FGD | Focus Group Discussion |
| ha | Hectare |
| SLM | Sustainable Land Management |
| SWC | Soil and Water Conservation |

## Background

Sub-Saharan Africa is particularly vulnerable to threats of natural resource degradation and poverty. This is due to various factors including a high population growth rate and increasing population pressure, reliance on agriculture that is vulnerable to environmental change, fragile natural resources and ecosystems, high rates of erosion and land degradation, and both low yields and high post-harvest yield losses. On top of this can be added sensitivity to climate variability and long-term climate change.

In Sub-Saharan Africa concerted efforts to deal with land degradation through Sustainable Land Management (SLM) practices must address water scarcity, soil fertility, organic matter and biodiversity. SLM seeks to increase production through both traditional and innovative systems, and to improve resilience to the various environmental threats.

The Ethiopian economy has its foundation in the agricultural sector. This sector continues to be a fundamental instrument for poverty alleviation, food security, and fueling economic growth. However, the sector continues to be undermined by land degradation in the form of depletion of soil organic matter, soil erosion, and lack of adequate plant-nutrient supply [1]. There is evidence that these problems are getting worse in many parts of the country, particularly in the highlands. Furthermore, climate change is anticipated to accelerate land degradation in Ethiopia. Over the last few decades, as a cumulative effect of land degradation, increasing population pressure, and low agricultural productivity, Ethiopia has become increasingly dependent on food aid. In most parts of the densely populated highlands, cereal yields average less than one metric ton per hectare [2]. Such low agricultural productivity, compounded by recurrent problems of famine, contributes to extreme poverty and food insecurity.

Therefore, in order to increase production from the land, water use efficiency and productivity need to be improved. This

can be achieved through the application of SLM practices such as by reducing high water loss through runoff and unperceived evaporation from unprotected soil, harvesting water, improving infiltration, and maximizing water storage - as well as by upgrading irrigation and managing surplus water. The first priority must be given to improving water use efficiency in rain fed agriculture; here lies the greatest potential for improved yields with all the associated benefits. For irrigated agriculture, conveyance and distribution efficiency are key water-saving strategies.

Efforts of understanding how farmers perceive land degradation have been numerous and diverse. In Ethiopia, adoption of soil conservation technologies was found to be affected by farmers' age, farm size and other factors including perceptions on technology profitability [3]. Another study in Ethiopia, farmers' negative attitude towards terraces was found to be contributed by their perception of terraces harboring rodents, reducing cultivation space and making of oxidization difficult [4]. In Kenya farmers' perceptions on the dangers of soil erosion were found to have a rational basis, but their assessment and behaviors were found to be incompatible with technical accords [5]. In Tanzania significant differences were observed between farmers and extension staffs in the way the two people perceived soil degradation [6]. Thus, to increase land productivity it is essential to follow and combine the principles of SLM practices like improving water use efficiency and water productivity, increasing soil fertility, managing vegetation and attending to the micro-climate. These synergies can more than double productivity and yields in small-scale agriculture. Further increases in productivity can also be achieved by intensification and/or diversification of production. The purpose of this study was, therefore, to investigate the degree of farmers' perception towards SLM practices taking the Teleyayen sub-watershed as a case study. The objective of this study was, therefore, to assess farmers' perception towards the effectiveness of SLM practices in the Teleyayen sub-watershed.

## Materials and methods

### The study area

The study area is located in Kutaber and Ambasel districts of Amhara Regional State of Ethiopia. Its geographical location extends from 11014'30''N and 11029'30''N latitude and 39021'0''E and 39033'0''E longitude (Figure. 1). The total area of the sub-watershed is about 152 square kilometers. The study area is inhabited by 20,296 people distributed within the sub-watershed. Its elevation ranges from 1,703 to 3,406 meters above mean sea level.

The land is highly degraded and the area is deforested in terms of indigenous trees but does have eucalyptus plantations in some areas. Topographically, the sub-watershed is characterized by a mountainous and highly dissected terrain with steep slopes and the rest are hilly (Figure. 2). It is drained by the headwaters of the Teleyayen River and its tributaries which flow to the Beshillo River, which forms part of the upper Abay (Blue Nile) basin.

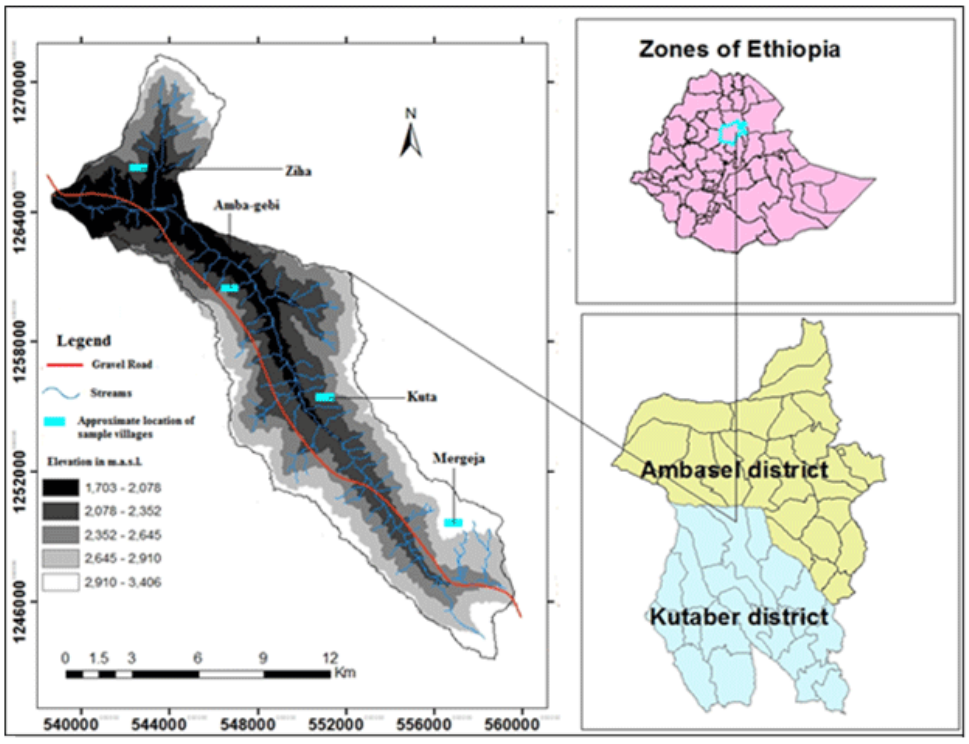


**Figure 1:** Location Map of the study area

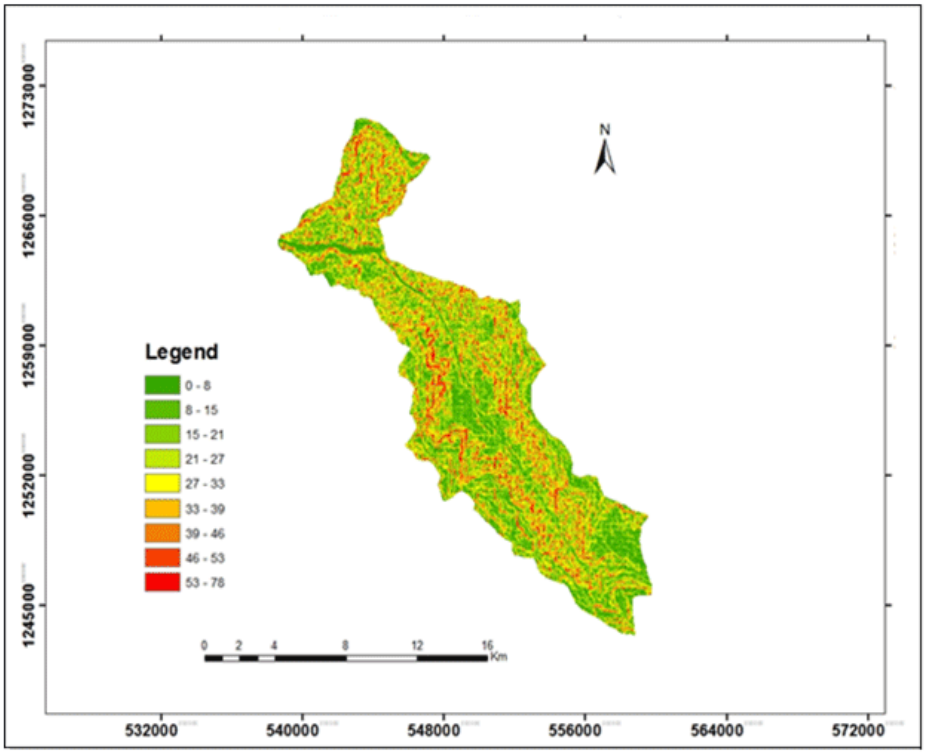


**Figure 2:** Slope of the Teleyayen sub-watershed

According to the local system, the country is classified into 5 agro-ecological zones, namely *Wurch, Dega, Weyna-Dega, Kolla* and *Berha* [7]. Wollo area has three distinct seasons namely winter, spring and summer. Winter is a dry season from October to January [8]. Spring is the small rainy season that occurs between mid-February and mid-May, while summer is the main rainy season that extends from mid-June to mid-September [8]. The mean annual temperature and mean annual rainfall ranges from $14^0$C to $20^0$C and from 680 mm to 1200 mm respectively [9]. Based on the moisture index, the climate of Wollo is classified as dry with arid to dry sub-humid conditions. According to the traditional climatic zones of the country, the study area stretches over the Upper-highland (Moist-*wurch*), Highland (Moist-*dega*), and Midland (Moist-*weyna-dega*) agro-ecological zones sharing 1%, 62% and 37% respectively (Figure. 3).

The mean annual temperature of the sub-watershed is about 160C and the average annual total rainfall is 1,133 mm (Figure. 4). More than 58% of the total rain falls in two months of July and August (summer season); while 18% falls in the spring season (March, April and May); and less than 5% of the total occurs during the dry months of December, January, and February (winter season).

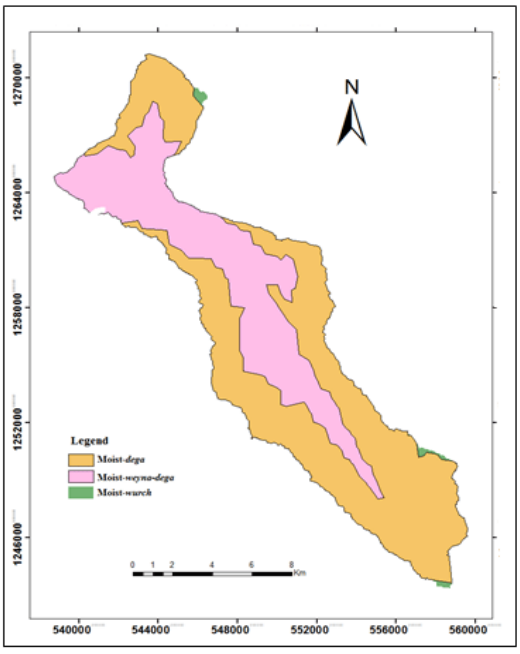


**Figure 3:** Agro-ecological zones of the study area

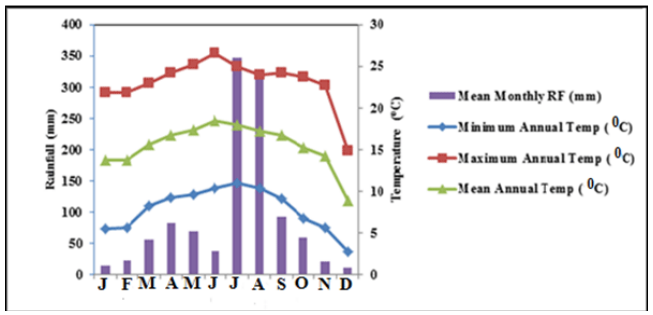


**Figure 4:** Min, max, and mean annual temperature (2006-2015) and mean monthly rainfall (2004-2013) of the study area

The major source of livelihoods for the local population is rain-fed agriculture. It is characterized by smallholder mixed farming systems where crop production and livestock rearing are simultaneously practiced. Land and livestock are therefore the most important assets of the people, with which they lead a sedentary life. Livestock provide the draught power and household members the labor that is needed for farming operation. Land is a scarce resource due to high population pressure and degradation. Most of the agricultural production is used for the farm household's own consumption. The major crops grown in the area include *Eragrostis tef, Triticum vulgare, Hordeum vulgaris, Avena sativa, Vicia faba, Pisum sativum, Solanum tuberosum, Zea mays, Sorghum spp., Piper nigrum* and *Allium cepa*. Spring rains are used for growing Trit*icum vulgare, Hordeum vulgaris* and pulses between January and April. Also, some villages in the lowland take advantage of spring rains to cultivate *Eragrostis tef*. Spring rains are also important for farmers in the mid-highland for growing long maturing varieties of *Eragrostis tef*, Sorghum spp. and *Zea mays*. Crop production is, therefore, the major source of income to the households. Incomes from off-farm employment include petty trading, weaving, and pottery.

## Sampling technique and methods of data collection

The data of this study was collected both from primary and secondary sources. The primary data were collected from a household questionnaire survey, FGD, key informant interview, and field observations. The questions included in the questionnaire were both closed ended and open ended types. The questionnaire was administered during January and February, 2016. This period was chosen mainly because it is an ideal time when farmers have completed their harvesting activities and started the natural resource development program work at the watershed level, which is carried out yearly by government led support. Hence, it is easy to interview the sample farm households and collect the required data. Secondary data were also collected from books, journals and internet sources. The sample farm household heads were drawn through a multi-stage sampling technique. The sampling technique involves three stages. In the first stage, the names of eight *kebeles* (six from Kutaber and two from Ambasel district) were obtained from each respective kebele administrators and then four sample *kebeles* (three from Kutaber and one from Ambasel district) were selected purposively. The reason for the selection of these *kebeles* is based on their agro-ecological zones and accessibility. In the second stage, four sample villages, one from each sample kebele, were selected randomly. In the third stage, the numbers of all farm households from each selected sample villages were listed. Finally, 172 male-headed and 43 female-headed a total of 215 sample farm households of the study were selected randomly from the four sample villages in a proportional-to-size of each agro-climatic zone (Table 1). These sample farm households were determined using the following formula provided by Yamane (1967) cited in [10].

**Table 1:** Distribution of sample farm households by district and village level

| District | Kebele | Village | Total households | | | Sample farm households | | | AEZ |
|---|---|---|---|---|---|---|---|---|---|
| | | | Male | Female | Total | Male | Female | Total | |
| Kutaber | Doshign | Mergeja | 19 | 9 | 28 | 1 | 1 | 2 | Moist-wurch |
| Ambasel | Teregma | Ziha | 123 | 28 | 151 | 63 | 14 | 77 | Moist-dega |
| Kutaber | Asecha | Kuta | 81 | 23 | 104 | 44 | 12 | 56 | Moist-dega |
| Kutaber | Amba-Gebi | Amba-gebi | 146 | 36 | 182 | 64 | 16 | 80 | Moist-weyna-dega |
| Total | | | 369 | 96 | 465 | 172 | 43 | 215 | |

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

Where, $n$ is the sample size

$N$ is the population size

$e$ is the level of precision (5%).

Based on the above formula, the total sample households were calculated as follow:

n = 465/1+465*0.0025 = 215

## Methods of data analysis

Data used for the study were analyzed, summarized and presented via quantitative and qualitative methods of data analysis. Statistical package for social sciences (SPSS-IBM) software, version 21 was used to analyze both inferential and descriptive data. Thus, using descriptive statistics like independent-sample t-test, chi-square, percentage, mean and standard deviation,

we compared and contrasted different categories of sample units with respect to the desired characteristics. Data collected using FGD and key informant interview were also analyzed in percentage and mean.

## Results and discussion

### Farmers' perception of soil erosion as a problem in the study area

Farmers' awareness about the problem and causes of soil erosion as well as its consequences will help to encourage them to invest in SLM practices. According to [11], perception of soil erosion as a threat to crop production and sustainable agriculture is the most important determinant factor for adoption of conservation measures, and he further states that understanding and recognition of soil erosion as a problem in own farm plots, and its causes and impacts on crop yields is the first step towards searching for and adoption of remedial measures. Therefore, farmers were asked about their perception on soil erosion problems prevailed in the study area. Yet, there were various reasons that motivated them; their perception was found to be encouraging. A large percentage of respondents (80%) agreed that erosion had threatened their farmlands, while (20%) of them felt nothing. Respondents who have not experienced any form of erosion are those whose farmlands are found on gentle slopes. These farmers explained that even though the risk of erosion is less, the shortage of farmland discourages them to produce more. About 70% of sample households perceived the soil erosion problem as severe, 15% as moderate, 10% as minor, and 5% no risk. However, in general although farmers are aware of erosion problems, their understanding of its severity is limited mostly to observable resultants of erosion on their farmlands like gully formation.

In order to understand farmers' perception towards the role of SLM practices to mitigate land degradation in the Teleyayen sub-watershed, farmers were also asked to indicate what they had noted regarding the short-term and long-term impacts of land degradation on their agricultural productivity. Accordingly, 54.9%, 34%, and 11.1% of them reported that the role of SLM practices to mitigate land degradation is high, intermediate, and low respectively.

### Statistical summary of descriptive statistics

Independent-sample t-test was used to indicate the mean differences between farmers who perceived and not-perceived the effectiveness of SLM practices for farmland improvements. Hence, the t-values of 7 continuous variables were calculated and out of these only the two variables mean differences were found to be significant (Table 2). These variables were age of the household heads and agricultural extension services provided to farmers. The result of the variable age of the household heads indicated that there is significant difference between the mean age of household heads who perceived and who do not perceived the practices. This means household heads who perceived the effectiveness of the SLM practices have an average age of 44.47 years and who do not perceive have an average age of 40.3 years. Likewise, there is significant difference between the mean of frequency of extension services provided for farmers who perceived (3.95) and who do not perceived (2.60).

Chi-square analysis was also conducted in order to know the correlation between farmers' perception and the effectiveness of SLM practices in the study area. Subsequently, out of the 7 variables included in the analysis, three were found to be significant. These variables were gender of the household head, land tenure security, and educational status of the household heads (Table 3).

**Table 2:** Summary of bio-physical characteristics of the study area

| Characteristics | Value and unit of measurement |
|---|---|
| Mean annual total rainfall | 1,133 mm |
| Mean annual temperature | 16oC |
| Distance from capital (Addis Ababa) | 441 km |
| Mean altitude | 2554.5 m.a.s.l. |
| Mean farm plot distance from homesteads | 1.3 km |
| Agro-ecological zone | Moist-weyna-dega, moist-dega, and moist-wurch |
| Major soil types | Leptosols, eutric cambisols, and eutric regosols |
| Rainfall regime | Bimodal (spring and summer) |
| Dominant livestock types | Cattle, sheep, goats, camels, pack animals and poultry |

**Table 3:** Mean differences of continuous variables on farmers' perception

| Variable | Perceived (N=185) | | Not-perceived (N=30) | | Total sample (N=215) | | t-value | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D | Mean | S.D | Mean | S.D | | |
| Age (years) | 44.47 | 12.36 | 40.3 | 9.65 | 42.38 | 11.01 | -1.761** | 0.08 |
| Agricultural labor force | 2.22 | 0.98 | 2 | 0.74 | 2.11 | 0.86 | -1.153 | 0.25 |
| Agricultural extension services | 3.95 | 1.5 | 2.6 | 1.1 | 3.3 | 1.3 | -4.600* | 0 |
| Farm plot distance (km) | 1.3 | 0.46 | 1.23 | 0.43 | 1.26 | 0.44 | -0.772 | 0.441 |
| Family size | 4.26 | 1.26 | 4.33 | 1.53 | 4.29 | 1.39 | 0.266 | 0.791 |
| Farm size (ha) | 1.07 | 0.27 | 1.1 | 0.3 | 1.08 | 0.28 | 0.391 | 0.696 |
| Livestock holding (TLU) | 3.34 | 1.58 | 3.46 | 1.75 | 3.4 | 1.66 | 0.381 | 0.704 |

**Education status of the household head:** The educational status of the household heads revealed that 72.6% of the households are illiterate. Among these households 76.8% perceived the effectiveness of SLM practice while 46.7% do not perceived. The chi-square result (X2=11.738) of this variable was found to be statistically significant at the 95% level of confidence. Hence, there is a significant relation between education status of the household heads and their perception about the effectiveness of SLM practices. This indicates that educated farmers perceived the importance of SLM practices for better productivity than their counterparts.

**Gender of the household head:** The statistical analysis of gender of the household heads indicated that 76.8% and 23.2% of male-headed and female-headed households were perceived the effectiveness of SLM practices respectively. The chi-square result (X2=8.716) of this variable was statistically significant at the 95% level of significance. This means there is a significant correlation between gender of the household heads and their perception towards the effectiveness of SLM practices.

**Land tenure security:** It refers to the right of individuals and groups of people to effective protection by their government against forcible evictions [12]. Chi-square statistical tool was used to know the relation between the farm households land tenure security and their perception towards the effectiveness of SLM practices. Thus, the analysis of the study showed that the chi-square result (X2=6.595) of this variable was found to be statistically significant at the 95% level of confidence. Hence, there is a significant association between land tenure security and farmers' perception towards the effectiveness of SLM practices. This result suggests that farmers' perception towards SLM practices is good if there is land tenure security.

## Bio-physical conditions and soil erosion occurrences in the Teleyayen sub-watershed

Land use changes, rapid population growth, poverty, climate change variability and lack of livelihood diversification are usually having the power to change the bio-physical characteristics of an area. The bio-physical attributes of this area includes soil types and distributions, temperature, rainfall, agro-ecological zones, and livestock types. In this regard, Table 4 presents the major bio-physical attributes of the study area.

**Table 4:** Summary of discrete variables of the study

| Variable | Perceived (N = 185) | | Not-perceived (N = 30) | | Chi-square value | Asymp. sig (2-sided) |
|---|---|---|---|---|---|---|
| | Number | % | Number | % | | |
| Education status of the HH head | | | | | | |
| Literate | 43 | 23.2 | 16 | 53.3 | 11.738* | 0.001 |
| Illiterate | 142 | 76.8 | 14 | 46.7 | | |
| Gender of the HH head | | | | | | |
| Male | 142 | 76.8 | 30 | 100 | 8.716* | 0.003 |
| Female | 43 | 23.2 | 0 | 0 | | |
| Access to credit service | | | | | | |
| Yes | 143 | 77.3 | 23 | 76.7 | 0.006 | 0.939 |
| No | 42 | 22.7 | 7 | 23.3 | | |
| Access to off-farm income | | | | | | |
| Yes | 32 | 17.3 | 7 | 23.3 | 0.633 | 0.426 |

| | | | | | | |
|---|---|---|---|---|---|---|
| No | 153 | 82.7 | 23 | 76.7 | | |
| Rainfall reliability | | | | | | |
| Yes | 9 | 4.9 | 1 | 3.3 | 0.137 | 0.712 |
| No | 176 | 95.1 | 29 | 96.7 | | |
| Soil erosion incidence | | | | | | |
| Yes | 180 | 97.3 | 29 | 96.7 | 0.038 | 0.846 |
| No | 5 | 2.7 | 1 | 3.3 | | |
| Land tenure security | | | | | | |
| Yes | 60 | 32.4 | 17 | 56.7 | 6.595* | 0.01 |
| No | 125 | 67.6 | 13 | 43.3 | | |

Biophysical conditions and land use methods influence watershed degradation owing to both natural and anthropogenic factors [13], as people continue to interact with the environment for their livelihood strategies. The survey analysis revealed that decline in crop productivity, loss of top soil and the occurrence of rills and gullies are the major indicators of soil erosion mentioned by farmers. As indicated in Table 5, a majority of the respondents (65.1%) reported that decline in crop productivity is the major indicator for the existence of soil erosion on their farmlands followed by the occurrence of rills and gullies (17.7%), and loss of top soil (14.8%).

**Table 5:** Farmers' response for indicators of soil erosion on their farmlands

| Indicators | Frequency | Percent |
|---|---|---|
| Decline in crop productivity | 140 | 65.1 |
| Loss of top soil | 31 | 14.8 |
| Rills and gully occurrence | 38 | 17.7 |

## Results obtained from focus group discussions

Focus groups are an effective ways to understand farmer's perception towards SLM practices. The selection of participants was made based on their specific characteristics like gender, farming experience, and age. Afterwards, two focus group discussions were formed for key informants. The key informants include kebele administrators, elders, and natural resource experts; each group of 8 persons is a mixture of both male and female. As a result 65% of the participants reported that the SLM practices conducted in their area is not effective because of farmers' reluctance to participate in soil and water conservation (SWC) practices, lack of incentives, poverty, and lack of awareness about the long-term benefits of such practices. On the other hand, 35% of them reported lack of adequate support from agricultural extension workers and recurrent drought occurrence, as the major obstacles for the implementation of SLM practices.

## Farmers' responses for factors affecting their land management practices

The survey result of the study showed that land tenure security problem (32.6%), is one of the major factors affecting farmers land management practices, followed by unaffordable price of fertilizer (27%), lack of assistance from development agents (15.8%), lack of credit access (14%), and negative perception towards land management practices (10.7%) (Figure.5). The result of the interview conducted with the key informants also indicated that the local community contributes to land degradation through cutting of trees for charcoal and firewood selling and non-maintenance of the remaining soil conservation structures which had constructed before.

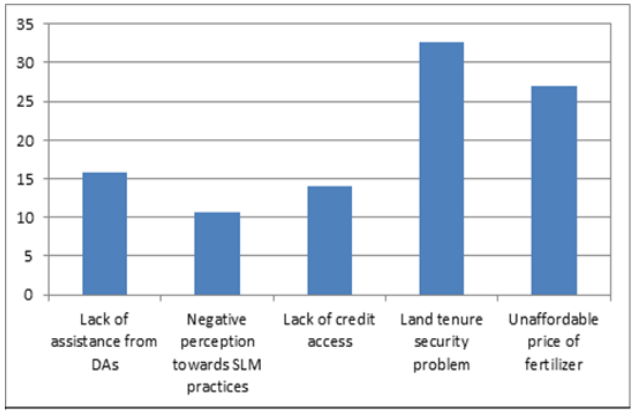


**Figure 5:** Farmers response for factors affecting their land management practices

## Farmers' perception about landholding sizes of the study area

The results of descriptive statistics indicated that 95.8% of the respondents were indicated that the landholding size they owned is unsatisfactory to support their households. Only 4.2% of them reported as satisfactory (Figure. 6). Therefore, this indicates the seriousness of the lack of farmland in the study area. This result suggests the need of livelihood diversification and population growth checking.

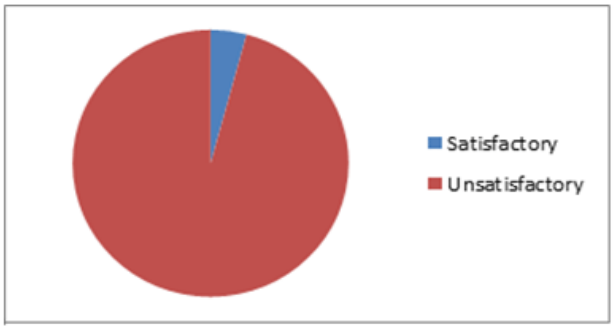


**Figure 6:** Farmers perception about landholding size

## Conclusions

This study investigated farmers' perception towards the effectiveness of SLM practices in the Teleyayen sub-watershed. A large percentage of respondents (80%) agreed that erosion had threatened their farmlands, while (20%) of them felt nothing. Specifically, about 70% of the households perceived the problem as severe, 15% as moderate, 10% as minor, and 5% no risk. Farmers were also asked about the short-term and long-term impacts of land degradation on their agricultural productivity. Accordingly, 54.9%, 34%, and 11.1% of them reported that the role of SLM practices to mitigate land degradation is high, intermediate, and low respectively. Independent-sample t-test was used to know the mean differences between farmers who perceived and not-perceived the effectiveness of SLM practices for farmland improvements. Hence, the t-values of 7 continuous variables were calculated and out of these the mean differences of the two variables, namely age of the household head and agricultural extension services provided to farmers were found to be significant. Moreover, the chi-square analysis of the study revealed that three variables were significant in explaining the correlation between farmers' perception and the effectiveness of SLM practices. These variables were gender of the household head, land tenure security, and educational status of the household heads.

On the other hand, results obtained from FGDs confirmed that farmers' reluctance to participate in SWC practices, lack of incentives, poverty, and lack of awareness about the long-term benefits of SLM practices, are the major reasons for the ineffectiveness of the SLM practice carried out in the study area. Furthermore, 35% of them reported that lack of adequate support from agricultural extension workers, and recurrent drought occurrence are the major obstacles for the successful implementation of SLM practices.

## Acknowledgements

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## Authors' contributions

Alem-meta Assefa Agidew has contributed in designing of the study, collection of data, analysis and interpretation of data and he wrote the manuscript. Dr. K. N. Singh also contributed in reviewing and writing the draft manuscript as well as editing the manuscript. Both authors read and approved the final manuscript.

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