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Study on Impact of Local Soil and Water Conservation Practices on Soil Quality in Bago Yoma Watershed Areas

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Abstract

This study is aimed to investigate local soil and conservation practices on soil quality in east and west area of Bago Yoma watershed. 108 soil samples were collected from non-conserved croplands and croplands with local soil and water conservation practices at three slope positions of these areas. The top soil (0–30 cm) samples were collected and soil physicochemical properties were determined following standard laboratory procedures. To generate survey data, 165 households were randomly selected from these areas and interviewed using a structured questionnaire. The results indicated that about 64% of the farmers adopted soil and water conservation practices. The dominant practices adopted in the study area were crop rotation, agroforestry and farmyard and their treated farmlands showed high mean values of the analyzed soil nutrients. Adoption of these practices was associated with levels of education, age of the farmers, the size of the land farmers held and social capital. However, the frequency of extension contacts in the adoption of SWC practices influenced negatively significant in east area. Therefore, awareness creation and demonstration of the effectiveness of these measures is essential for sustainable land management practices in this area.

Keywords:, watershed, soil and water conservation practices , erosion, sediment

ပဲခူးရိုးမ ရေဝေရေလဲဧရိယာရှိ ဒေသခံများ၏ ရေနှင့်မြေဆီလွှာ ထိန်းသိမ်းရေး အထောက်အကူပြု စိုက်ပျိုးနည်းစနစ်များအပေါ် မြေဆီလွှာအရည်အသွေးဆိုင်ရာ အကျိုးသက်ရောက်မှုအား လေ့လာခြင်း

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စာတမ်းအကျဉ်းချုပ်

ယခုလေ့လာမှုသည် ပဲခူးရိုးမရေဝေရေလဲဧရိယာ၏ အရှေ့ဘက်နှင့် အနောက်ဘက်ဒေသများရှိ ဒေသခံများ၏ ရေနှင့်မြေဆီလွှာထိန်းသိမ်းရေး အထောက်အကူပြု နည်းစနစ်များ လက်ခံကျင့်သုံးမှုအပေါ် မြေဆီ လွှာအရည် အသွေးအခြေအနေအား လေ့လာခဲ့ပါသည်။ ၎င်းဒေသများရှိ ဒေသခံများ၏ ရေနှင့်မြေဆီလွှာထိန်းသိမ်းရေး အထောက်အကူပြုနည်းစနစ် ဆောင်ရွက်သည့် နေရာနှင့် ဆောင်ရွက်မှုမရှိသည့် နေရာများတွင် လျှောစောက်အဆင့်အတန်းအလိုက်မြေနမူနာ ၁၀၈ ခု ကောက်ယူခဲ့ ပါသည်။ အပေါ်ယံမြေလွှာအနက် ၀-၃၀ စင်တီမီတာတွင် ကောက်ယူပြီး၊ မြေဆီလွှာဂုဏ်သတ္တိများ အား ဓါတ်ခွဲခန်းစံစနစ်များအတိုင်းဓါတ်ခွဲစမ်းသပ်ခဲ့ပါသည်။ စုစုပေါင်း အိမ်ထောင်စု ၁၆၅ ဦးအားရွေးချယ်၍ ရေနှင့်မြေဆီလွှာ ထိန်းသိမ်းမှုနမူနာမေးခွန်းများဖြင့် အင်တာဗျူး မေးမြန်းခြင်းဖြင့် စစ်တမ်း ကောက်ယူခဲ့ပါသည်။ လေ့လာတွေ့ရှိချက်များအရ ၎င်းဧရိယာများတွင် သီးနှံအလှည့်ကျစနစ်၊ သီးနှံသစ်တောရောနှောစနစ်၊ ဥယျာဉ်ခြံစနစ်၊နွားချေးမြေဩဇာ အသုံးပြုစနစ်၊ အရွက်ကြွေဖုံးခြင်းစနစ်နှင့် မြေအနားပေးစိုက်ပျိုးစနစ် လက်ခံကျင့်သုံးကြောင်း တွေ့ရှိရပါသည်။ လေ့လာတွေ့ရှိချက်အရ ဒေသခံများ၏ ၆၄ ရာခိုင်နှုန်းခန့်သည် လက်ခံကျင့်သုံးကြောင်း တွေ့ရှိရပြီး ၎င်းတို့၏ မြေယာများတွင် မြေဆီလွှာ အဟာ ရဓါတ် တိုးတက် ကောင်းမွန်ကြောင်း တွေ့ရှိရပါသည်။ ရေနှင့်မြေဆီလွှာထိန်းသိမ်းရေး အထောက်အကူပြုနည်းစနစ်များ လက်ခံကျင့်သုံးမှုအပေါ် မြေဆီလွှာတိုက်စားမှု ပြဿနာဖြစ်ပေါ်မှုအား သိရှိနားလည်ကြောင်း တွေ့ရှိရသော်လည်း ပဲခူးအရှေ့ဘက်ခြမ်းရှိ ဒေသခံအများစုသည် စည်းရုံးပညာပေး တက်ရောက်မှု အားနည်းကြောင်း တွေ့ရှိရပါသည်။ ထို့ကြောင့် မြေယာစီမံအုပ်ချုပ်မှု ရေရှည်တည်တံ့စေရန် ၎င်းဒေသခံများအား မြေဆီလွှာ လက်ခံကျင့်သုံးမှုဆိုင်ရာ စည်းရုံးပညာပေးခြင်းနှင့် လက်တွေ့သရုပ်ပြသခြင်းများ ဆောင်ရွက်ရန် လိုအပ်ပါသည်။

Study on Impact of Local Soil and Water Conservation Practices on Soil Quality in Bago Yoma Watershed Areas

1. Introduction

Globally about 40% of agricultural land is seriously degraded with 80% of this degradation caused by soil erosion. This loss of land resources remains a major concern, particularly in developing countries where agriculture is the backbone of the economy. (Milkessa Asfew et.al, 2023)

In Bago Yoma watershed area, livelihood of the people are mainly based on subsistence farming. shifting cultivation practices are vulnerable to soil erosion and lead to reduced soil fertility (Billy,2005). Soil erosion not only affects agricultural production but it also disturbs environmental and ecological functions performed by soil. This continued erosion and degradation is an indication that either farmers' adoption of corrective technologies is too slow or there are some limiting social-economic, technological and institutional factors (Mhinte, 2018).

The ever-growing population in the area has led to pressure on land resources in terms of land fragmentation, and poor traditional practices with related effects like declining soil fertility and erosion. In this direction, community forestry and agroforestry system with some sound resource conservation techniques have been strengthened for long-term sustainable production and environmental conservations in fragile ecosystem. (Forest Department, 2018).

The introduction of SWC measures such as contour buffer strips, agroforestry, gully/ grade stabilization, mulching, water ways and cover cropping, was seen as an opportunity for replenishing the already depleted soils. However, farmers may practice different conservation measures depending on their degree of perception of the problem of land degradation and awareness of the conservation measures available around them (Shiferaw and Bantilan, 2004).

Previous studies show that various personal, economic, socio institutional and biophysical attributes have influential roles in farmers' decisions about the adoption of soil and water conservation measures in different parts of Myanmar This relationship between attributes has not yet been studied in this area. Appropriate understanding of these factors in the study area would assist in the formulation and implementation of the policy interventions designed to induce voluntary continued use of soil and water conservation measures

2. Objective

(i) to evaluate the effects of soil and conservation practices on selected soil physicochemical properties

(ii) to assess farmers' perception on soil and water conservation measures assess the benefit obtained from soil and water conservation structures

3. Literature Review

"Watershed" is an area of land that supplies water through surface or subsurface flow in to a specific water body-a stream, lake, river or ocean. The land and water use, and its management practices decide the flow characteristics of watershed and its relationship with the watershed. Degradation of watershed refers the long-term degradation of quantity and quality of soil and water in a watershed (Ashoori et al. 2016). Watershed management is defined as the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, and human communities within a watershed boundary. Watershed management includes the sensible use of natural resource with active participation of institutions, organization, peoples and having a consciousness with the ecosystem (Sahieen Syed Meeran.et al, 2020)

The adoption of soil conservation practices is a complex process (de Graaf et al., 2008). Here, various factors come into play: personal and family factors (such as, attitudes, knowledge, family situation, migration), social factors (such as, technical support, land tenure, migration), physical factors (such as, slope, erosivity and climate variability, soil erodibility), institutional factors and collective action (such as, rules, standards, community work), as well as economic factors (Helena Cotler and Maria Luisa Cuevas, 2018).

Incorporating the knowledge built over decades to centuries into conservation initiatives requires knowledge governance, understood as-a fluid and historical processes of co-evolution between agents, organizations and institutional arrangements, and the knowledge they help to create and reproduce‖ (Manuel-Navarrete and Gallopin, 2012). The patterns of knowledge governance affect the mainstreaming of sustainability practices and integrate knowledge about their multiple dimensions. Due to the wide variety of ecosystem services performed by soils, no single level of governance can provide incentives for users to safeguard their long-term delivery (Orchard and Stringer, 2016). There is also growing acknowledgement that centralized, top-down mechanisms are inadequate for tackling land degradation as well as ensuring the sustainable use of natural resources more widely (Nagendra and Ostrom, 2012). Experience has shown that there is no-best practice‖ or innovative policy approach that can be applied to any type of region (Tödling and Tippl, 2005), and that no conservation practice is a panacea that can be adopted everywhere (Hudson, 1987).

General experience from the field and literature indicates that successful, scaled up and durable adoption of new technology requires consideration of both agroecological and socioeconomic factors affecting the incentives and constraints to adopt (Arslan et al., 2014). It is however important to differentiate between the adoption of a new technology, generally done to increase economic profitability, and the adoption of a conservation strategy, which implies transforming the agroecosystem (de Graaff et al., 2008)

4. Material and method

4.1 Study Area

The Bago Yoma is situated between N 16º 50' and 19º 29', E 94º 41' and 97º 13'. It includes Bago (East) and Bago (West) areas, covering an extent of 38,672.49 km^2 . The study was conducted at Swa Chaung dam watershed area in Yetashae Township in the East of Bago Yoma area and Taungnawin dam watershed area in Paukkong Township in the west of Bago Yoma area. It is an ideal place for teak. Elevation is fairly lower than 1000 m forming undulating mountain ranges. The climate is humid, subtropical with a peak rainfall occurring between mid-June to mid-September (long rainy season) and within a smaller (short rainy season) from February to May, with mean annual rainfall of 1700 mm. The mean annual minimum and maximum temperature being 11 and 25 ◦C respectively.

4.2 Soil sampling and analysis techniques

For soil sampling, a total of 18 plots were selected from six villages in two watershed. Among these, 9 plots were from farmlands treated with soil and water conservation structures as treated (experimental plots) and the other 9 plots were with no SWC practices as a control plots (cultivation land adjacent to each structure) with the same land use system. Even though the structures were common between 3 to above 30% slope, the samples were collected from 3−18% slope based on land use practice. Accordingly, the farm land was divided into three slope classes as lower slope (3-8%), middle slope (8-13%), and upper slope (13-18%) and soil samples (0-20cm depth) were taken from each layer following Dejene Teressa (2017).

On the other hand, soil samples for control plots were collected from the 0-30 cm depth at four corners and center of a plot of 10m x10m size using "X" sampling design (Marges a n d Schinner, 2005) using sharp edged and closed circular auger pushed manually down the soil profile. Therefore, based on the terrace site position, soil and water conservation practice and study kebeles, 108 composite soil samples (6villages*3 replication * 2 areas * 3 slope gradients) w e r e collected. Then after, the samples mixed thoroughly in clean plastic bucket to form a composite sample and analysis was made in the laboratory for selected physicochemical properties of soil. The soil samples were air-dried at room temperature, grounded, homogenized, and passed through a 2 mm sieve before laboratory analysis. The analysis was carried out in the soil laboratory of FRI following standard procedures as (Pritchett & Tin Tin Ohn,1981)

4.3. Method of data collection for household survey

Cochran's (1967) sample size determination method was used to randomly select 165 households in both sub-watershed areas. Structured questionnaires were used to collect demographic, socio-economic, institutional and physical farmland characteristics from sample households via face-to-face interview. Focus Group Discussion was conducted to collect qualitative information and to further strength the quantitative data. The discussion was made with experts, Development Agents (DAs) and office holders in the study area. In this study, smallholder farmers were stratified as adopters (those who implemented physical SWC measures on their own farmland and non-adopters (those who did not practiced physical SWC measures).

4.4. Statistical analysis

One-way analysis of variance (ANOVA) was used to test the significant difference of soil parameters due to soil and water conservation practices considering three slope positions at a $P < 0.05$ level of significance following the normality test using Pearson's correlation using SPSS 16.0

Descriptive statistics like mean, standard deviation, percentage, frequency, minimum and maximum were executed. Chi square test was used to analyze factors determining the decision of farmers to adopt SWC practices which is a dichotomous dependent variable.

5. Results

5.1 Socio-economic characteristic of the respondents

The average age of respondents in east area and west area had 52 and comparable farmland size which was about 1.4 ha and 3.0 respectively. For east site, the average educational level was grade 5, whereas it was grade 9 for west site. Farmland plots were an average of 1.32 km far apart from the home of the respondents (Appendix 1).

More than half of the respondents (30%) replied that they had at most three times extension contact per year, while the other half said they had at least one. 70% of respondents had farmland with gentle slope and other respondents had farmland with steep slope.

Chi-square test result showed a significant relationship between east site and west site in the adoption of physical SWC and explanatory factors such as farmland size, farm experience, awareness about the importance of SWC, and frequency of extension contact. (Appendix 1).

5.2. Soil and water conservation practices adopted in study region

The soil and water conservation practices adopted in study region were categorized into 6; agronomic (mulching, agroforestry, home garden, crop rotation, fallowing and manure application. There were significant differences between Soil and water conservation practices adopted in this region. Table 1 shows the popularity of adoption of each of the technology in the study area.

The most common soil and water conservation practices used in east area included crop rotation and mulches by (35%) and (20%) of the farmers, farmyard manure (18.3%), fallowing (16.7%), and homegardern 10 %.

According to respondents, the top three known indigenous SWC practices in the west area were agroforestry practices (33.3%), crop rotation (20%), and application of manure (30%), whereas the least practiced were mulching (10%) and fallowing (6.7%).

Figure 1. The soil and water conservation practices adopted in study areas

5.3. Farmers' Perception on Soil Erosion

Care of the farmers' soil erosion in these watersheds are the most important conditions for assessing their perception of soil and water conservation measures. The chi-square test showed that perceiving a problem of soil erosion demonstrated a significant association with the adoption of SWC practices. (Appendix 2,3)

Among the soil and water conservation users, 26.2%, 40% and 8.8% describe the rates of soil erosion on their cropland as moderate, minor, and none, respectively. Of the nonuser groups, 10%, and 15% perceived soil erosion as severe, moderate of soil erosion on their farm.

In west area, 29.4% of respondents opined that the degree of soil erosion on their farm land was moderate and 37.6% ,28.2%and 4.7 of respondents mentioned erosion on their farm as none, minor and serve respectively.(Figure 2)

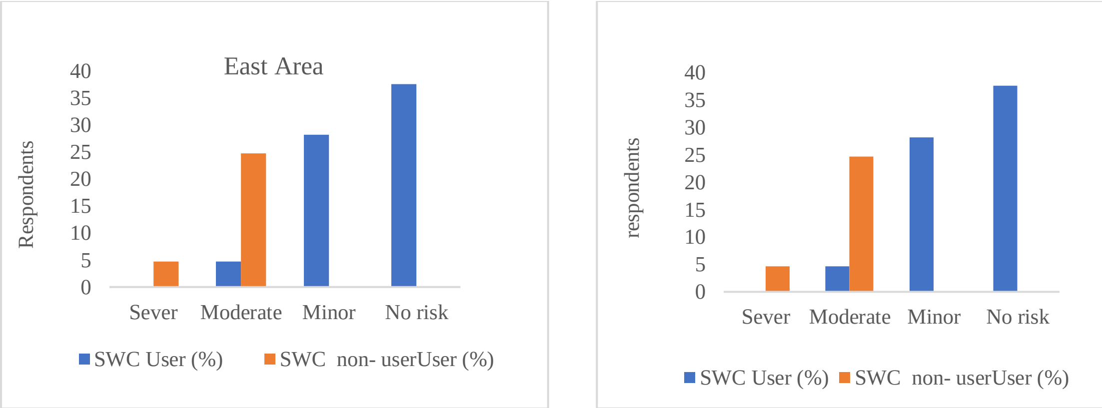

Figure.2 Farmer perception on the severity of soil erosion in study areas (n=165)

5.4 Soil physicio -chemical properties in soil and water conservation practices

Soil conservation practices are more successful in enhancing soil health. Analyzed soil parameter values showed significant variation with regard to conservation measures. However, the interaction between conservation measures and slope effect was not statistically significant. (Appendix 4,5) The mean physicio -chemical in soil value between treated and the non-treated plots are shown in Table 1.

The textural class of the soil was discovered to be clay loam in conserved and non-conserved plots of west area and the other were sandy -loam.

The soil pH values in the study region ranged from 5.96 to 7.28 in the non-conserved plots and conserved plot. Similarly, the soil pH in east site was slightly acidic and west site was moderately alkaline reaction. ANOVA findings showed that mean soil pH differences between conservation measures and the control plot were not significant.

Results of the experiment indicated that both soil organic matter and total nitrogen were significantly influenced by the conservation and slope position of the farmlands in both watersheds.

The mean values of soil organic matter on conserved farmlands (6.87%) and (7.57%) were significantly higher as compared to (2.65%) and (2.50%) on non-conserved farmlands in east and west areas sub-watershed, respectively.

Similarly, the mean value of total nitrogen of the soil on conserved farmland (0.100%) and (0.120%) was significantly higher as compared to (0.031%) and (0.033%) on non-conserved farmlands in the east and west watersheds, respectively

Cation exchange capacity was significantly influenced by the implemented SWC measures of the farmlands. The mean values of cation exchange capacity on conserved farmlands 27.6 cmol /kg) and (31.31 cmol /kg) was significantly higher as compared to (9.78 cmol/kg) and (17.26 cmol /kg) non-conserved farmlands in east and west areas, respectively (Table 1).

Although numerical higher in conserved farmland, there was no statistically significant difference in available phosphorus between conserved and non-conserved farmlands at both areas.

Table.1 The mean physicio -chemical soil properties in study areas

Aera	plot	pH	N %	P %	OM %	CEC cmol/kg	Sand %	Silt %	Clay %	
East area	conserved	6.06 ±0.16	0.102±0.05	0.0005±0.53	6.87±0.0.18	27.53±0.0	61	22	14	Sandy-Loam
	non conserved	5.96±0.18	0.031±0.10	0.0005±0.55	2.49±0.22	9.78±0.1	58	25	14	Sandy-Loam
West area	conserved	7.28±0.44	0.124±0.16	0.0006±0.65	7.57±0.32	31.13±0.11	34	37	28	Clay-Loam
	non conserved	7.28±0.49	0.033±0.10	0.0004±0.44	2.65±0.29*	17.26±0.11	36	35	27	Clay-Loam

6. Discussion

6.1 Sustainable soil and water conservation practices adopted in two sub watersheds

Interestingly, because most ethnic people continue to maintain their traditional food and cultural habits, they still prefer the traditional food crops and SWC measures to conserve their land. In-depth investigations by several studies (FAO, 1984; Tidemann, 1996; Morgan, 2005; Mishra et al., 2013; Manivannan et al., 2017) have observed by working closely with local communities that indigenous practices have a significant role to play in conserving our SWC resources and cultivation systems.

Soil erosion is prevented by several mechanical, agronomic/biological and soil fertility management techniques. Farmers have adopted number of conservation measures based on their criteria to evaluate the efficiency of particular conservation measure. These criteria include their social, economic and local physiographic conditions such as slope, altitude, crop preference, the yield capacity of the soil and financial ability to invest in the soil. These traditional SWC measures have been devolved based on their decades of practices and knowledge which contribute to long term sustainability of land and maintain agriculture production. However, changes in socioeconomic and environmental conditions prompted farmers to develop innovative farming practices that draw heavily on the principles of traditional knowledge system and modern knowledge system.

During the field survey, physical observation of farms in the study villages revealed that the farmers living closer to streams and rivers developed elaborate agroforestry system. Agroforestry is one of the significant conservation practices in the west area. The watershed is characterized by farm forest-based agroforestry and high-value cash crops-based agroforestry. Various studies have reported the ecological and economic benefits of agroforestry practices (Sharma et al., 1997; Sharma et al., 2009; Mishra et al., 2013) in Sikkim Himalaya

Fallowing, a conservation technique which involves the practice of leaving the land out of production for 3-5 years for the purpose of restoring soil fertility and minimizing soil loss, was the least practiced indigenous SWC technique. Some of farmer in eat site practiced fallowing to the land is traditional way of soil conservation.

6.2 Factors influencing the adoption of SWC practices and the perception of traditional farmers towards SWC

Farmers' knowledge and perception regarding soil erosion severity play a great role in the likelihood to adopt or not adopting conservation practices. Accordingly, the perception of farmers on soil erosion problem seriousness was positive and significantly influenced their decisions to adopt SWC practices in both areas (Table.2). Age of members of the household influences overall soil and water conservation efforts of the household. Through experience, farmers perceive and understand the problem of soil erosion and the decline in the fertility of the soil and the use of improved soil and water conservation technology in controlling soil erosion, (Addisu Damtew Atnafe et.al2015)

The adoption of physical SWC techniques has been positively and significantly influenced extension training in west area. The result showed that responsibility in the kebele increases the opportunity to participate in various meetings and opportunities This implies that respondents created the opportunity to meet development agents, to ask and understand, and correspondingly increased the adoption of soil and water conservation technology. (W. Kebede, N.2014)

The adoption of SWC techniques has been negatively and significantly influenced by awareness of the importance of SWC measures in east area. This suggests that farmers' capacity to adopt physical SWC would rise as their understanding of the significance of soil management increased. Additionally, raising awareness about the effects of soil erosion and the importance of SWC measures motivates farmers to take action.

Some of the factors such as age of household, farm land size, distance have negatively influenced the decision of farmers to adopt soil and water conservation practices in this study indicate farmers willingness to adopt SWC measures decreases with increase in those explanatory variables .

Table 2. Results of Pearson correlation between major respondents variables in the study areas.

Variable	East area	N	West area	N
practices	.803**	80	. 768**	85
acre	-.653	80	.-502**	85
age	-.024	80	-.066	85
experience	-.307**	80	-.993**	85
distance	-.976**	80	.-.843**	85
education	-112	80	.728**	85
training	-.522**	80	.843**	85
perception	.800**	80	.800**	85

**. Correlation is significant at the 0.01 level (2-tailed). N = Number of respondents

6.3 The effect of soil and water conservation practices on soil chemical properties

The influence of land use on the effect of conservation measures for the mean difference of soil pH was slight. The mean pH of the soil in the study watershed was 5.77 and 5.66 in conserved and non-conserved land in east site respectively (Table 3). The acidity of the soil could be related with its sub-humid nature of the area and high amount of rainfall. This is true that greater rainfall increases soil acidity and humid areas are more acidic than arid and semi-arid areas (Osman 2013).

It could be explained by soil erosion, continuous cultivation, harvesting crop residues, and animal dung. The use of animal dung for fuel instead of manure may reduce the effectiveness of SWC practices in SOC concentration (Mengistu et al. 2016).

Higher proportion of fine soil particles (clay fraction) was observed in both conserved and non-conserved farmlands in west site. Even though, higher clay fraction observed in conserved farmlands as compared to the respective non-conserved farmlands, this variation did not affect the soil textural classes. The observed lower clay fraction on non-conserved farm plots in east site might be due to selectively transporting the fine fractions, leaving behind the coarser fraction because of the high mean annual precipitation over the study area or inherited heterogeneity in soil formation process.

The higher SOC observed in the farmlands with soil bund could probably be accumulated and retained soil organic matter due to soil and water conservation measures. Whereas the lowest SOC on non-conserved farmlands might be attributed to the loss of top soil by water erosion due to lack of soil and water conservation structures. Similarly, the mean value of total nitrogen of the soil on conserved farmland was significantly higher as compared to non-conserved farmlands in both areas. This could be attributed to the lesser manifestation of soil erosion that resulted from the relatively higher availability of soil organic matter due to soil and water conservation measures. The lower amount of total nitrogen was observed on non-conserved farm plots, which might be due to intensive cultivation, serious erosion because of a lack of soil and water conservation structures and the lower addition of organic and inorganic fertilizer to the soil. Besides, the decrease in total nitrogen might be contributed by the decrease in soil organic carbon, which might have occurred due to intensive and continuous cultivation.

Following the rating of Landon (1991), CEC greater than 40 is categorized as very high, 26 to 40 as high, 13 to 25 as medium, 6 to 12 as low, and less than 6 as very low. According to this rating, the amount of CEC on conserved farmland was rated as high for both sub-watersheds, and on non-conserved farmlands, it was rated as high to medium in east and west areas, respectively. This demonstrates a strong correlation between CEC and soil clay content, which influenced positively the availability of cation exchange capacity in the soil.

7. Conclusion and recommendation

The study revealed that soil and water conservation practices influenced some soil physical and chemical properties in both watersheds. Traditional and modern practices improved soil properties such as soil organic carbon, total nitrogen and cation exchange capacity. The improvements in soil properties can help to create awareness among small holder farmers. Adoption of these practices was associated with levels of education, age of the farmers, the size of the land farmers held and social capital. However, the frequency of extension contacts in the adoption of SWC practices influenced negatively significant in east area. Therefore, awareness creation and demonstration of the effectiveness of these measures is essential for sustainable land management practices in this area.

As a result, it’s critical to design soil and water conservation methods that combine modern scientific understanding with traditional knowledge in order to spread them and maintain their long-term sustainability.

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	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
user	80	1.00	2.00	1.2500	.04872	.43574
practices	80	1.00	6.00	3.7250	.19240	1.72087
acre	80	.30	3.00	1.4575	.10214	.91358
age	80	45.00	60.00	52.1875	.51745	4.62818
experience	80	5.00	56.00	20.0125	1.05160	9.40575
distance	80	.00	1.50	.9900	.06588	.58927
education	80	3.00	5.00	4.4500	.08697	.77786
training	80	.0	1.0	.450	.0560	.5006
perception	80	1.00	4.00	2.5750	.09543	.85351
Valid N (listwise)	80					

Appendix1

Descriptive Statistics of respondents (user &non user) in east area

Descriptive Statistics of respondents(user &non user) in west area

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
user	85	1.00	2.00	1.2941	.04971	.45835
practices	85	1.00	6.00	3.5765	.21261	1.96018
acre	85	1.00	5.00	3.0000	.14591	1.34519
age	85	45.00	60.00	52.0353	.46486	4.28577
experience	85	7.00	30.00	23.0588	1.01091	9.32017
distance	85	.00	1.00	.4412	.03687	.33992
education	85	3.00	13.00	8.9176	.39115	3.60625
training	85	1.0	3.0	1.882	.0737	.6798
perception	85	1.00	4.00	2.0118	.10111	.93215
Valid N (listwise)	85					

Chi square test of **respondents (user &non user) in east area**

Test Statistics									
	user	practices	acre	age	experience	distance	education	training	perception
Chi-Square	20.000[a]	13.150[b]	13.125[c]	15.300[d]	78.550[b]	5.200[e]	30.700[e]	.800[a]	22.900[d]
df	1	5	4	3	5	2	2	1	3
Asymp. Sig.	.000	.022	.000	.002	.000	.074	.000	.000	.000

Chi square test of **respondents (user &non user) in west area**

Test Statistics									
	user	practices	acre	age	experience	distance	education	training	perception
Chi-Square	14.412[a]	24.059[b]	9.165[c]	77.282[b]	35.059[d]	16.471[e]	33.835[f]	16.471[e]	20.459[c]
df	1	5	3	5	4	2	6	3	3
Asymp. Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000

Appendix 2a

swc practices in east site

			practices						
			home garden	intercropping	mulching	farmyard	fallowing	cultivator	Total
user	adopter	Count	6	21	12	11	10	0	60
		Expected Count	4.5	15.8	9.0	8.2	7.5	15.0	60.0
		% within user	10.0%	35.0%	20.0%	18.3 %	16.7%	.0%	100.0%
		% within practices	100.0%	100.0%	100.0%	100.0%	100.0%	.0%	75.0%
		% of Total	7.5%	26.2%	15.0%	13.8%	12.5%	.0%	75.0%
	nonadopter	Count	0	0	0	0	0	20	20
		Expected Count	1.5	5.2	3.0	2.8	2.5	5.0	20.0
		% within user	.0%	.0%	.0%	.0%	.0%	100.0%	100.0%
		% within practices	.0%	.0%	.0%	.0%	.0%	100.0%	25.0%
		% of Total	.0%	.0%	.0%	.0%	.0%	25.0%	25.0%
Total		Count	6	21	12	11	10	20	80
		Expected Count	6.0	21.0	12.0	11.0	10.0	20.0	80.0
		% within user	7.5%	26.2%	15.0%	13.8%	12.5%	25.0%	100.0%
		% within practices	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	7.5%	26.2%	15.0%	13.8%	12.5%	25.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	80.000[a]	5	.000
Likelihood Ratio	89.974	5	.000
Linear-by-Linear Association	46.605	1	.000
N of Valid Cases	80		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is 1.50.

Soil erosion perception in east site

			perception				Total
			no rick	minor	moderate	serve	
user	adopter	Count	7	32	21	0	60
		% within user	11.7%	53.3%	35.0%	.0%	100.0%
		% within perception	100.0%	100.0%	72.4%	.0%	75.0%
		% of Total	8.8%	40.0%	26.2%	.0%	75.0%
	nonadopter	Count	0	0	8	12	20
		% within user	.0%	.0%	40.0%	60.0%	100.0%
		% within perception	.0%	.0%	27.6%	100.0%	25.0%
		% of Total	.0%	.0%	10.0%	15.0%	25.0%
Total		Count	7	32	29	12	80
		% within user	8.8%	40.0%	36.2%	15.0%	100.0%
		% within perception	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	8.8%	40.0%	36.2%	15.0%	100.0%

Appendix 2b

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	49.103[a]	3	.000
Likelihood Ratio	55.811	3	.000
Linear-by-Linear Association	38.459	1	.000
N of Valid Cases	80		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.75.

Appendix 3a

Soil erosion perception in west site

			perception				
			no riskk	minor	moderate	serve	Total
user	adopter	Count	32	24	4	0	60
		Expected Count	22.6	16.9	17.6	2.8	60.0
		% within user	53.3%	40.0%	6.7%	.0%	100.0%
		% within perception	100.0%	100.0%	16.0%	.0%	70.6%
		% of Total	37.6%	28.2%	4.7%	.0%	70.6%
	nonadopter	Count	0	0	21	4	25
		Expected Count	9.4	7.1	7.4	1.2	25.0
		% within user	.0%	.0%	84.0%	16.0%	100.0%
		% within perception	.0%	.0%	84.0%	100.0%	29.4%
		% of Total	.0%	.0%	24.7%	4.7%	29.4%
Total		Count	32	24	25	4	85
		Expected Count	32.0	24.0	25.0	4.0	85.0
		% within user	37.6%	28.2%	29.4%	4.7%	100.0%
		% within perception	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	37.6%	28.2%	29.4%	4.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	68.816[a]	3	.000
Likelihood Ratio	81.002	3	.000
Linear-by-Linear Association	53.740	1	.000
N of Valid Cases	85		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.18.

Appendix 3b

SWC practices in west site

			practices						Total
			agroforestry	intercropping	mulching	farmyard	fallowing	cultivator	
use	adopter	Count	20	12	6	18	4	0	60
		Expected Count	14.1	8.5	4.2	12.7	2.8	17.6	60.0
		% within user	33.3%	20.0%	10.0%	30.0%	6.7%	.0%	100.0%
		% within practices	100.0%	100.0%	100.0%	100.0%	100.0%	.0%	70.6%
		% of Total	23.5%	14.1%	7.1%	21.2%	4.7%	.0%	70.6%
	nonadopter	Count	0	0	0	0	0	25	25
		Expected Count	5.9	3.5	1.8	5.3	1.2	7.4	25.0
		% within user	.0%	.0%	.0%	.0%	.0%	100.0%	100.0%
		% within practices	.0%	.0%	.0%	.0%	.0%	100.0%	29.4%
		% of Total	.0%	.0%	.0%	.0%	.0%	29.4%	29.4%
	Total	Count	20	12	6	18	4	25	85
		Expected Count	20.0	12.0	6.0	18.0	4.0	25.0	85.0
		% within user	23.5%	14.1%	7.1%	21.2%	4.7%	29.4%	100.0%
		% within practices	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	23.5%	14.1%	7.1%	21.2%	4.7%	29.4%	100.0%

Appendix 4a

ANAVOA Analysis of sand conserved and non conserved plots in east area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	111.155	1	111.155	1.208E3	.000
	Error	1.667	18.112	.092[a]		
slope	Hypothesis	.056	2	.028	.077	.926
	Error	9.128	25.313	.361[b]		
Sand	Hypothesis	1.383	16	.086	.239	.997
	Error	7.487	20.676	.362[c]		
slope * Sand	Hypothesis	8.310	23	.361	1.041	.490
	Error	4.167	12	.347[d]		

ANAVOA Analysis of CEC in conserved and non conserved plots in east area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	108.248	1	108.248	52.572	.000
	Error	12.360	6.003	2.059[a]		
slope	Hypothesis	.026	2	.013	.950	.412
	Error	.179	12.990	.014[b]		
CEC	Hypothesis	12.622	6	2.104	154.423	.000
	Error	.166	12.193	.014[c]		
slope * CEC	Hypothesis	.163	12	.014	.673	.764
	Error	.667	33	.020[d]		

ANAVOA Analysis of OM in conserved and non conserved plots in east area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	60.220	1	60.220	32.542	.002
	Error	9.303	5.027	1.851[a]		
slope	Hypothesis	.004	2	.002	.265	.769
	Error	.262	31.039	.008[b]		
OM	Hypothesis	12.067	5	2.413	472.671	.000
	Error	.052	10.219	.005[c]		
slope * OM	Hypothesis	.031	7	.004	.195	.985
	Error	.875	39	.022[d]		

Appendix 4b

ANAVOA Analysis of pH in conserved and non conserved plost in east area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	97.391	1	97.391	1.058E3	.020
	Error	.092	1	.092[a]		
slope	Hypothesis	.792	2	.396	.106	.904
	Error	7.459	2	3.729[b]		
pH	Hypothesis	.092	1	.092	.026	.888
	Error	7.217	2.005	3.599[c]		
slope * pH	Hypothesis	7.459	2	3.729	29.917	.011
	Error	5.983	48	.125[d]		

ANAVOA Analysis of p in conserved and non conserved plots in east area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	121.212	1	121.212	64.183	.000
	Error	11.351	6.010	1.889[a]		
slope	Hypothesis	.024	2	.012	.753	.488
	Error	.240	15.129	.016[b]		
P	Hypothesis	12.303	6	2.050	132.619	.110
	Error	.190	12.319	.015[c]		
slope * P	Hypothesis	.185	12	.015	.763	.682
	Error	.667	33	.020[d]		

ANAVOA Analysis of N in conserved and non conserved plots in east area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	81.379	1	81.379	109.649	.000
	Error	10.430	14.053	.742[a]		
slope	Hypothesis	.073	2	.036	1.339	.284
	Error	.570	21	.027[b]		
N	Hypothesis	11.739	14	.838	31.139	.000
	Error	.565	21	.027[c]		
slope * N	Hypothesis	.625	21	.030	.	.
	Error	.000	16	.000[d]		

Appendix 5a

ANAVOA Analysis of Clay in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	111.859	1	111.859	1.049E3	.000
	Error	2.602	24.388	.107[a]		
slope	Hypothesis	.114	2	.057	.189	.829
	Error	10.070	33.315	.302[b]		
Clay	Hypothesis	.926	13	.071	.246	.995
	Error	7.519	26	.289[c]		
slope * Clay	Hypothesis	7.519	26	.289	.694	.790
	Error	5.000	12	.417[d]		

ANAVOA Analysis of silt in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	110.250	1	110.250	1.013E3	.000
	Error	2.269	20.842	.109[a]		
slope	Hypothesis	.042	2	.021	.065	.937
	Error	9.802	30.606	.320[b]		
Silt	Hypothesis	1.148	13	.088	.277	.991
	Error	8.296	26	.319[c]		
slope * Silt	Hypothesis	8.296	26	.319	.957	.559
	Error	4.000	12	.333[d]		

ANAVOA Analysis of sand in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	112.500	1	112.500	1.139E3	.000
	Error	1.713	17.341	.099[a]		
slope	Hypothesis	.148	2	.074	.203	.818
	Error	10.851	29.693	.365[b]		
Sand	Hypothesis	1.315	14	.094	.247	.996
	Error	10.630	28	.380[c]		
slope * Sand	Hypothesis	10.630	28	.380	2.278	.098
	Error	1.500	9	.167[d]		

Appendix 5b

ANAVOA Analysis of CEC in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	124.519	1	124.519	49.441	.001
	Error	12.593	5	2.519[a]		
slope	Hypothesis	.037	2	.019	1.000	.402
	Error	.185	10	.019[b]		
CEC	Hypothesis	12.593	5	2.519	136.000	.000
	Error	.185	10	.019[b]		
slope * CEC	Hypothesis	.185	10	.019	1.000	.462
	Error	.667	36	.019[c]		

ANAVOA Analysis of OM in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	100.180	1	100.180	27.711	.013
	Error	10.862	3.004	3.615[a]		
slope	Hypothesis	.012	2	.006	.552	.592
	Error	.115	10.394	.011[b]		
OM	Hypothesis	12.485	3	4.162	432.671	.000
	Error	.058	6.074	.010[c]		
slope * OM	Hypothesis	.058	6	.010	.470	.827
	Error	.857	42	.020[d]		

ANAVOA Analysis of N in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	115.126	1	115.126	48.051	.001
	Error	11.988	5.003	2.396[a]		
slope	Hypothesis	.019	2	.010	.781	.480
	Error	.146	11.764	.012[b]		
N	Hypothesis	12.462	5	2.492	207.242	.000
	Error	.124	10.297	.012[c]		
slope * N	Hypothesis	.120	10	.012	.574	.824
	Error	.750	36	.021[d]		

Appendix 5c

ANAVOA Analysis of p in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	126.436	1	126.436	34.524	.010
	Error	10.989	3.001	3.662[a]		
slope	Hypothesis	.062	2	.031	.874	.463
	Error	.219	6.161	.036[b]		
P	Hypothesis	11.063	3	3.688	104.154	.014
	Error	.214	6.039	.035[c]		
slope * P	Hypothesis	.212	6	.035	.696	.654
	Error	2.133	42	.051[d]		

ANAVOA Analysis of pH in conserved and non conserved plots in west area

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	109.877	1	109.877	6.244E3	.000
	Error	.199	11.310	.018[a]		
slope	Hypothesis	.011	2	.006	.296	.747
	Error	.458	23.584	.019[b]		
pH	Hypothesis	.015	2	.007	.767	.501
	Error	.064	6.685	.010[c]		
slope * pH	Hypothesis	.030	4	.007	.025	.999
	Error	13.400	45	.298[d]		