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Impacts of Soil and Water Conservation Measures on Selected Soil Quality Attributes at Jima Bako Area, Western Ethiopia

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Abstract: The problem of soil erosion is one of the major environmental problems contributing to food insecurity. It needs to attention to carried out conservation measures to reduce the problem of soil erosion and to improve the food insecurity. However, the impact of soil and water conservation measures on soil quality attributes has not been well investigated in the Bako Tibe district, Western Ethiopia. Therefore, this study was undertaken to investigate the impact of soil and water conservation measures on selected soil quality attributes in the study area. Soil samples were taken from cultivated land (teff and maize) and grazing land from conserved and unconserved sites at the depth of 0-20 cm from top and bottom slope positions. Data were analyzed with one-way analysis of variance (ANOVA) using SAS version 9.2 following GLM procedure. The results of the study revealed that soil quality attributes, such as soil bulk density, porosity and soil pH were affected by soil and water conservation practices and slope gradients and results were statistically significant ($p < 0.05$). With the exception of soil pH, all studied chemical attributes such as Soil Organic Matter, Total Nitrogen, Available Phosphorus, Exchangeable Bases such as K^+, Mg^{2+} and Ca^{2+} and CEC of the soil under the conserved and un conserved sites were not affected by SWC practices and slope positions.

Keywords: Impacts, Soil and Water Conservation, Soil Erosion, Soil Quality Attributes

1. Introduction

Soil quality is the capacity of soil to interact with the ecosystem in order to maintain the biological productivity, the quality of other environmental resources, and thus promoting the health of biota, including humans [11]. Soil quality may deteriorate quickly due to poor land management, stabilize with time under improper management, vary slightly because of the weather and growing conditions, and improve in the long time for the supply of Organic Matter [21]. Soil erosion is the ultimate cause for loss of topsoil which helps plant growth. As a result, crop roots are exposed to soil with high clay content, pH, and Cation Exchange Capacity (CEC) and lower organic matter, Phosphorous, and Nitrogen [22].

"Several soil physical and chemical properties that could serve as attributes of soil quality" [3]. Mismanagement of agricultural practices affect soil health and soil functions, in the way of altering the soil's physical, chemical and biological properties and its related functions. For instance, in Ethiopia farmers plow the land up and down the slope [17]. As a result, the land is exposed to water and wind erosion. Also, plowing exposes the top soil and part of the soil profile to air that stimulates oxidation of the soil carbon and decreases soil organic matter [24]. Decrease in soil quality presents an insurmountable challenge for the poor peasant in the highland areas because they have limited resources to improve soil quality and the land resource [28].

The aggravation of soil structure through soil compaction and declining values of soil organic matter have also contributed to higher levels of soil erosion [13]. Soil erosion has detrimental effects on soil quality and productivity since the majority of soil nutrients and soil organic matter are stored in the topsoil that is susceptible to soil erosion and become leached.

The consequences of runoff and erosion are the impairment of the quality and productivity of land. Moreover, the impact of soil and water conservation measures on soil quality attributes has not been well investigated in the Bako Tibe district, Western Ethiopia. Therefore, the objective of this paper was to determine the impact of soil and water conservation measures on selected soil quality attributes at conserved and unconserved sites and slope gradients at Jima Bako area, western Ethiopia.

2. Material and Methods

2.1. Geographical Environment of the Study Area

The study was conducted at Bako Tibe district of west Shewa zone of Oromia national regional state, western Ethiopia. The district is located at about 250 and 125 km from Addis Ababa and Ambo respectively along the main road to the west direction of Ethiopia. It is bounded by the Jima Rare and Jima Geneti in the North, Cellia and Ilu Galan District in the East and Gobu Sayo and Gudeya Bila district in the West and Boneya Boshe district in South. Geographically, the study area lies between 9° 00' to 9° 10' N latitude and 37° 00' to 37° 9' E longitudes and at an altitude of 1650 meter above sea level (masl) (Figure 1). The total area of the district is about 644.94 km^2 [2].

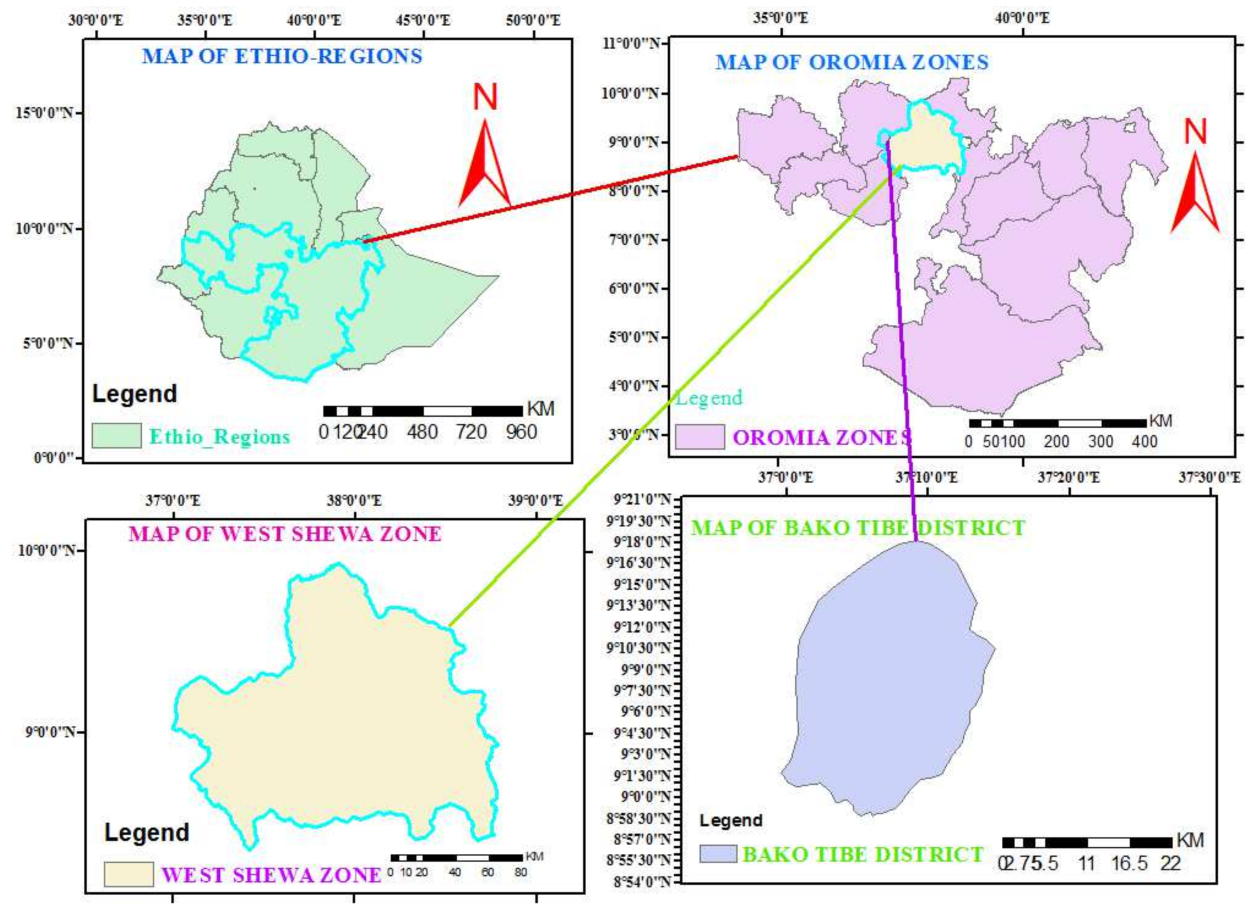

Figure 1. Location map of the study area.

The topography of the study area is slightly undulating especially in the highlands and almost flat in the lowlands. The study area has 22% steep, 60% flat, 4.5% gorge, 5% hill and 5.2% others [10]. The long-term weather data (1990 to 2017) revealed that the area has a unimodal rainfall pattern, and mean annual rainfall was observed as 1273 mm and average relative humidity is 67.2%. The rainy season covers from April to October, and maximum rain was received in the months of June, July and August [2]. About 80% of the mean annual rainfall is received from June to September. It has a warm humid climate with the mean minimum, mean maximum and average air temperatures of 13.4, 28.49 and 20.95°C respectively [10]. The study area covers three agro-ecological zones: low land (Gammoojjii) 51%, midland (Badda Daree) 12%, and high land (Baddaa) 37% based on temperature, rainfall, altitude and vegetation covers. The high altitude zone occupies the largest area followed by mid and low altitude climatic zones respectively. The study area has relatively favorable agricultural potential, which is reflected in the diversity of crops and animal resources. The area has different land use/cover 54.25% of land is arable or cultivable, 23.98% is for pastures, and 5.12% of land is covered by forest and 16.65% of the land is for built upland [10]. The major soil types of the study area are red soil

(Biyyoo Diimaa) 55%, Black cotton Soil/Vertisols (Biyyoo Kooticha) 5%, Black soil (Biyyoo Gurraacha) 15% and Brown soil (Biyyoo Magaala) 25% [10]. The dominant soil in the area is reddish brown in color Nitosols. The textural class of soil of the study area is dominantly clay and loam in texture [4]. The study area is endowed with diverse vegetation species ranging from little dense and old natural forests in pocket areas at tips of both up and down stream sides, to the patch of sparse shrub-grass complex in various areas. Dominant tree species in the area include Cordia africana (Waddeessa), Ficusvaita (Qilxuu) and Croton mycrostachyus (Bakkaniisa), Acacia abysinica (Laaftoo), Vernonia amygadalina (Eebicha), Ocimum sauva (Hancabbii), Grewia ferruginea (Dhooqonuu), Calpurnia aurea (Ceeka), Olea Africana (Ejersa), and the exotic tree species Eucalyptus camalduleses (Bargamoo diimaa) are the main vegetation species of the study area. Eucalyptus camalduleses (Bargamoo diimaa) is widely found in the study area. The drainage pattern of the study area is stretched from North to South directions. The study area has the major rivers such as Gibe (laga gibe), Sama (laga saama), Jima (laga Jimaa), Qela (laga Qallaa), Mara (laga Maraa), Leku (laga Lakkuu), and Habuko (laga Habukkoo). Precipitation is the main source for recharge of these rivers flow in the study area [10]. The district has 28 rural and 4 urban peasant association/kebeles. The total population size of the district is 65,293 men and 68,291 women totally 133,584 with a total house hold size of 22,880. The area is characterized by mixed farming system where the major livestock raised are Cattle, Sheep, Goat, Equines, and Poultry. The major annual and perennial crops of the area include Maize (Zea mays L.), Sorghum (Sorghum bicolor), Teff (Eragrostis tef), Wheat (Tiriticum vulgare), Barley (Hordeum vulgare), Nigger seed (Guizotia abyssinica), Beans (Vicia faba) and Peas (Pisumsativum), Hot pepper (Capsicum frutescense L.), Haricot bean (Phaseolus vulgar L.), Sweat potato (Ipomoea batatas Lam), Mango (Mangifera indica L.), Banana (Mussa spp), and Sugar cane (Saccharum officinarum L.) in order of importance. Other diverse forms of livelihoods observed in the study area includes small-scale irrigation from rivers, springs and drainage for temperate and sub-temperate fruit and cash crop production (vegetables such as Onion (Allium cepa), Garlic (Allium sativum), Potato (Solanum tuberosum), Cabbage (Brassica oleracea), Tomato and different types of spices. Maize and Pepper are the dominant crops grown in the area [10].

2.2. Soil Sampling

Soil samples were collected from the conserved and unconserved sites from above five years after adoption on the farmland and grazing land for the conservation measures (soil bund, and stone bund) in the study area. The surface particle was removed from the site. The soil samples were collected from top and bottom plots from the farmland (maize and teff) and grazing land from (0-20 cm) depths. The slope ranges of the sampled area were from flat to gentle (< 10%) at bottom part, and Steep (> 20%) on the top part was considered when was the soil sampled, as it has been done by some other researchers [29].

From both slope positions, a total of six plots from both conserved and unconserved areas under three land uses, 4 under maize land, 4 under teff and also 4 under grazing land with 12 composite surface samples and 12 cores taken for laboratory analysis. The composite soils were a total 12 samples where each sample site is located at 10m distance from others and was dug in the area of 20m×20m. The soil was taken by auger the four corners and in the center of the square plot uniformly from three land use.

2.3. Soil Analysis

The soil samples were air-dried, mixed well and were passed through a 2 mm sieve for chemical analysis. Separate soil core samples from the 0-15cm depths were taken with a sharp-edged steel cylinder of 5cm height and 5cm diameter forced manually into the soil for bulk density determination.

Soil analysis was carried out at Bako Agricultural Research Center. The samples were analyzed for selected soil attributes. Organic Carbon (Walkley and Black, 1934), Total Nitrogen (TN) by Kjeldhal digestion method [5]. Available phosphorus (Pava) [9] by extraction method, exchangeable cations (Ex. K) flame photometer, and Mg and Ca and cation exchange capacity (CEC) determined by extraction method with ammonium acetate EDTA titration [5]. The soil pH (H_2O-1:2.5) suspension determined by pH meter [5]. Percent SOM was obtained by multiplying percent Soil Organic Carbon (SOC) by a factor of 1.724 based on the assumptions that OM is composed of 58% carbon. The undisturbed soil sample was used to determine soil moisture and bulk density. Bulk density of undisturbed soil samples was determined using core sampler (cylindrical metal sampler) [6]. Total porosity was calculated from the bulk density and specific particle density of 2.65g/cm^3 [23]. It was calculated by using the below formula:

$$TP = 1 - \frac{BD}{PD} \times 100\%$$

Soil moisture content was determined by the oven drying method (Blake, 1965). Soil moisture was determined by using the following formula:

$$\text{Moisture content (\%)} = \frac{\text{weight of fresh soil} - \text{weight of oven dry soil}}{\text{Weight of oven dry soil}} \times 100$$

2.4. Statistical Data Analysis

The laboratory data obtained from the soil samples were analyzed with one-way analysis of variance (ANOVA) following GLM procedure using SAS version 9.2 [27] Software to detect whether there was significant effect on soil attributes between land uses and slope gradients of the conserved and unconserved sites. Mean comparisons (LSD) were calculated for the different land uses, slope gradients and conserved and unconserved sites. In all the analyses, confidence level was held at 95% and $P < 0.05$ was pinpointed for significance.

3. Results and Discussions

3.1. Effect of Soil and Water Conservation on Selected Soil Physical Quality Attributes

Table 1. *Effect of SWC on selected soil physical quality attributes under land uses, conserved and unconserved and slope gradients.*

Treatments	Bulk density g/cm^3)	Porosity (%)	Moisture Content (%)
Land uses			
TL	1.40^b	52.87^b	16.81^a
ML	1.39^b	52.47^b	17.89^a
G L	1.53^a	57.99^a	16.59^a
CV (%)	4.15	3.99	51.8
LSD (5%)	0.1	3.63	11.92
F-test	0.02**	0.01**	0.11
CUCS			
Conserved	1.46^a	55.25^a	13.35^a
Un-conserved	1.42^a	53.65^a	14.17^a
CV (%)	4.15	3.99	51.8
LSD (5%)	0.08	2.97	9.74
F-test	0.23	0.24	0.84
Slope gradients			
Top	1.47^a	55.62^a	10.44^a
Bottom	1.41^b	53.27^b	17.1^a
CV (%)	4.15	3.99	51.8
LSD (5%)	0.08	2.97	9.74
F-test	0.11	0.10	0.15

**= Highly significant, TL=Teff Land, ML=Maize Land, GL= Grazing Land, CUCS=Conserved and unconserved sites, NS= Not significant, Means within a column followed by the same superscript are not significantly different at ($P < 0.05$).

3.1.1. Soil Bulk Density (Pb)

The value of bulk density was highly significant ($p < 0.05$) affected by land uses for maize land and grazing land. However, numerically the highest mean value of bulk density was recorded under grazing land (1.53 g/cm^3). It was due to the livestock trampling, causes soil compaction on the grazing land and the lowest mean value of the bulk density was recorded under maize land (1.39g/cm^3) and teff land (1.40 g/cm^3) respectively. This is agreement with the findings of some authors [22, 24] who reported that livestock can alter the landscape and affect soil quality through grazing. Animal grazing changes the land cover by decreasing soil organic matter and soil aggregate, promoting surface crusting and inhibiting water infiltration. Reduced organic matter (OM) in soil can affect a lot of other soil quality indicators. For example, it reduces the amount of water in soil. And also, Bulk density is a common measure of degree of compaction or total porosity [32].

The bulk density of the conserved and unconserved site was not significantly ($p > 0.05$) affected by soil and water conservation practices in the study area. The mean value of bulk density recorded under conserved area was (1.46 g/cm^3) and the unconserved was (1.42g/cm^3). The study result indicated that the value of bulk density was not significantly ($p > 0.05$) affected by slope gradients. The mean value for both top and bottom slope gradients were (1.47g/cm^3) and (1.41g/cm^3).

As White (1997) classification the values of bulk density ranges from < 1 g/cm^3 for soils high in SOM, 1.0 to 1.4g/cm^3 for well aggregated loamy soils and 1.2 to 1.8 g/cm^3 for sands and compacted horizons in clay soils. Accordingly, the maize land and teff land were belonging to well aggregated loamy soils and the grazing land incorporated under compacted clay soils. Both slope gradients class and the conserved and unconserved sites were also under compacted clay soils.

3.1.2. Total Porosity (Tp)

The study result showed that, the total porosity was highly significantly ($p < 0.05$) affected by land uses. Numerically, the highest mean value of total porosity was recorded under grazing land (57.99%) and under maize and teff the mean value of total porosity was (52.47%) and (52.87%) respectively. In this study, the soil and water conservation did not affect the total porosity and the nearly mean value was recorded in both conserved and unconserved sites and did not significant ($p > 0.05$) and numerically, (55.25%) and (53.65%) from conserved and unconserved sites respectively. In addition to this the slope also focused under this finding. The result indicated that the slope gradients did not influence the total porosity and the mean value for both top and bottom was recorded (55.62%) and (53.27%) respectively and was not significantly ($p > 0.05$) different.

3.1.3. Soil Moisture Content (SMC)

Soil Moisture content value was not significantly ($p > 0.05$) affected by land uses and the SWC practices did not significantly affect the moisture content whereas the slope gradients also not affect the soil moisture content of the sites. The moisture content of the soil varied in mean value (the bottom slope gradients has higher than the top slope gradients this is because of sedimentation and siltation deposited in lower gradients). [18, 20] Soil moisture content can be described in terms of weight of water per unit weight of soil or volume of water per unit volume of soil. It is influenced by many factors for example soil texture, soil depth, soil structure and temperature.

3.2. Effect of Soil and Water Conservation on Selected Soil Chemical Quality Attributes

3.2.1. Soil pH (Soil Reaction)

The analysis result indicated that the value of the pH was not significantly (p > 0.05) affected by land uses numerically the mean values were expressed as 5.76 Teff land, 5.69 Maize land and 5.75 Grazing land respectively. The soil pH was significantly (p≤0.05) affected by soil water conservation.

However, numerically the mean value of soil pH recorded as 5.8 conserved (the highest pH value) and 5.67pH from unconserved. The value of soil pH highly significantly (p < 0.05) affected by slope gradients. The soil pH of the study area was incorporated under moderately acidic soil. This is due to intensive cultivation systems where large amounts of N are recycled through the system, and when substantial amounts of organic products and residues removed.

Table 2. *Effect of SWC on selected soil chemical quality attributes under land uses, CUCS and slope gradients.*

Treatments	pH (1:2.5 H_2O)	%OC	%OM	%TN	P_{ava} (ppm)	Ex.K (Cmol(+)/Kg Soil)	Ex.Mg (Meq/100g soil)	Ex.Ca (meq/100g Soil)	CEC (meq/100g soil)
Land uses									
TL	5.76[a]	1.34[b]	2.31[a]	0.11[a]	11.5[a]	0.48[a]	16.25[a]	28.25[a]	12.05[a]
ML	5.69[a]	2.1[a]	3.61[a]	0.18[b]	15.2[b]	0.285[a]	17.0[a]	24.25[a]	15.55[a]
GL	5.75[a]	2.1[ba]	3.53[a]	0.17[ba]	11.5[a]	0.252[a]	17.75[a]	22.25[a]	16.40[a]
CV (%)	1.64	24.66	24.72	24.20	39.76	105.7	57.96	22.81	25.5
LSD (5%)	0.16	0.75	1.30	0.063	8.47	0.599	19.71	9.50	6.25
F-test	0.54	0.08	0.08	0.08	0.51	0.64	0.35	0.36	0.28
CUCS									
CS	5.8[a]	2.05[a]	2.77[a]	0.13[a]	14.6[a]	0.38[a]	21.83[a]	27.5[a]	15.47[a]
UnC	5.67[a]	1.61[a]	3.53[a]	0.17[a]	10.8[a]	0.29[a]	18.83[a]	22.3[a]	13.87[a]
CV (%)	1.64	24.66	24.72	24.20	39.76	105.7	57.96	22.81	25.5
LSD (5%)	0.13	0.61	1.06	0.05	6.92	0.49	16.09	7.76	5.11
F-test	0.05*	0.13	0.13	0.11	0.23	0.67	0.67	0.15	0.48
Slope gradients									
Top	5.83[a]	1.75[a]	3.02[a]	0.15[a]	12.5[a]	0.368[a]	17.33[a]	26.5[a]	14.46[a]
Bottom	5.65[b]	1.9[a]	3.27[a]	0.16[a]	13.0[a]	0.31[a]	23.33[a]	23.3[a]	14.87[a]
CV (%)	1.64	24.66	24.72	24.20	39.76	105.7	57.96	22.81	25.5
LSD (5%)	0.13	0.61	1.06	0.05	6.92	0.49	16.09	7.76	5.11
F-test	0.01**	0.59	0.59	0.56	0.86	0.78	0.40	0.36	0.85

TL= Teff Land, ML= Maize Land, GL= Grazing Land, NS= Not significant, Means within a column followed by the same superscript are not significantly different at (P < 0.05).

3.2.2. Soil Organic Matter (SOM) and Total Nitrogen (TN)

The value of soil organic carbon and organic matter was not significantly (p > 0.05) affected by land uses. Numerically, the mean value of the soil organic carbon and organic matter recorded were (1.34, 2.31% Teff land), (2.1, 3.61% Maize land) and (2.05, 3.53% Grazing land) respectively. Under this study, the soil and water conservation also not statistically affect the value of Soil organic carbon and organic matter (p > 0.05), whereas the slope gradients also not significantly affect.

According to Tekalign M. Haque and Heluf Gibrekidan et al. [29, 19], the rating classes of the soil organic carbon and organic matter was identified as < 0.5% SOC very low, 0.5-1.5% SOC low, 1.5-3% SOC moderate, > 3% SOC high and < 0.86% SOM very low, 0.86-2.59% SOM low, 2.59-5.17% SOM moderate, and > 5.17% SOM high respectively. Based on the classification the soil of the study area has low organic carbon and organic matter under teff land, moderate organic carbon and organic matter under maize land and moderate under grazing land. Maize land also has high organic carbon and organic matter than other land uses.

The value of total nitrogen was not significantly (p > 0.05) affected by land uses, soil water conservation practices and slope gradients. The mean value of these were (0.11 Teff land, 0.18 Maize land, and 0.175% Grazing land), (0.13 Conserved, 0.17% Unconserved) and (0.15 top, 0.16% bottom). [29, 19] the percentage of total nitrogen ranges from < 0.01% low, 0.01-0.12% moderate, and 0.12-0.25% high. According to this the soil of study area has high percentage of total nitrogen.

Wakene Negasa [32] stated that there was a 30% and 76% depletion of total nitrogen from agricultural cultivated for 40 years and abandoned land, respectively, compared to the virgin land in Bako area, western Ethiopia. Lack of nitrogen is the greatest single cause of low crop yield. The total amount of nitrogen present in soils, nearly 95-99% is in organic form and 1-5% in the inorganic form as ammonium and nitrates. It is a major competent of soil organic matter which contains an average of about 5 percent nitrogen [15].

3.2.3. Available Phosphorous (P_{ava}) and Exchangeable Basis (ExaB)

The results of soil analysis of available phosphorus content revealed that, soil and water conservation practices were not significant impact on the availability of phosphorus. The mean value of the conserved and unconserved site were 14.66 and 10.8ppm respectively, but it was not significantly (p > 0.05) affected by soil and water conservation practices. On the other hand erosion is high before conserved and absence of continuous application of mineral P fertilizer might cause. The land under maize has the higher mean value than others but statistically it was not significant ($p > 0.05$) and slope gradients also not affect the available phosphorous (P_{ava}). The results of [18] also showed that available phosphorous did not significantly varied ($p > 0.05$) both with the SWC and slope gradients. Phosphorus is normally strongly bonded to soil particles and is therefore easily transported down slope during erosion, giving higher concentrations of available P in the soil accumulation zone of terraces [36]. In another ways crop harvesting and residue removes the available Phosphorous accumulated by cereal crops. The deficiency of available Phosphorus (P_{ava}) in fertility is recognized as one of the most limiting factors in plant growth and productivity.

Under this study the exchangeable cations such as K^+, Mg^{2+} and Ca^{2+} was focused. The study result revealed that, the exchangeable basis (Ex.K^+ (Cmol (+)/Kg soil, Ex. Mg^{2+} (Meq/100g soil, and Ex. Ca^{2+} (meq/100g soil) were not statistically significant ($p > 0.05$) affected by the soil and water conservation practice and slope gradients. Even the land use pattern did not affect the exchangeable basis statistically.

However, numerically the mean value of these basis recorded under land uses, conserved and unconserved and top and bottom slope gradients were (0.48 Teff land, 0.285 Maize land, 0.252 Cmol (+)/Kg soil Grazing land, 16.25 Teff land, 17.0 Maize land, 17.75 Meq/100g soil Grazing land and 28.25 Teff land, 24.25Maize land, 22.25 meq/100g soil) Grazing land) and 0.385 Conserved, 0.293 Cmol (+)/Kg soil Unconserved, 21.83 Conserved, 18.83 Meq/100g soil Unconserved and 27.5 Conserved, 22.3 meq/100g soil Unconserved) and (0.368 top, 0.31 Cmol (+)/Kg soil bottom, 17.33 top, 23.33 Meq/100g Soil bottom and 26.5 top, 23.3 meq/100g soil bottom) respectively. According to food and agriculture organization (2006) exchangeable cations classified as below.

Table 3. *Exchangeable cations rating classes.*

Rating class	Ex. K(CMOL(+)/Kg soil)	Ex. Mg (Meq/100g soil)	Ex. Ca (Meq/100g soil)
Very low	< 0.2	< 0.3	< 2
Low	0.2-0.3	0.3-1.0	2-5
Moderate	0.3-0.6	1.0-3.0	5-10
High	0.6-1.2	3-8	10-20

FAO (2006).

According to the above rating, the exchangeable potassium (Ex. K^+) under teff land was moderate, under maize land was low and under grazing land also low and moderate under conserved and low under unconserved and in slope gradients in both top and bottom it was moderate. The exchangeable magnesium (Ex.Mg^{2+}) was high according to the above rating in land uses, conserved and unconserved sites and slope gradients and also has higher mean value in conserved site than unconserved and high in the down slope gradients. Also the exchangeable calcium (Ex.Ca^{2+}) was also high as above table and the maize land has higher exchangeable calcium than others.

3.2.4. Cation Exchange Capacity (CEC)

The value of cation exchange capacity (CEC) revealed that the soil water conservation, the land uses and slope gradients were not statistically significant ($p > 0.05$) affect the value of cation exchange capacity (CEC). By comparing the difference, the mean value of grazing land (16.40meq/100 g soils) was greater than maize land (15.55meq/100g soil) and teff land (12.05meq/100 g soils) also lower than maize land. Depletion of organic matter as a result of intensive cultivation has reduced the CEC under the cultivated lands [32]. This result is in harmony with other findings that reported CEC value was lowest in cultivated land in Bako area, western Ethiopia [2]. The mean value of the conserved site (15.47meq/100g soil) was greater than un conserved site (13.87 meq/100g soil) by cation exchange capacity. In slope gradients the value of the CEC was not statistically significant but has low mean value difference between top and bottom slope position. The more fertile the soil tends to be, the more clay the soil tends to have the more organic matter, a soil tends to have the higher the CEC [16]. Soils with CEC less than 16meq/100g are considered not to be fertile. Such soils are usually highly weathered. Likewise in the study area from sampled land uses grazing land merely have CEC greater than 16meq/100g. The high CEC values imply that the soil has high buffering capacity against the induced changes [19].

4. Conclusion

In this study soil and water conservation structures mainly five-year-old soil bunds and stone bunds on the selected soil quality attributes of different land uses (Maize land, Teff land and Grazing land), conserved and unconserved sites and slope gradients of the site were investigated.

The results of the study revealed that soil quality attributes, such as bulk density, porosity affected by land uses and soil pH was affected by soil and water conservation practices and slope gradients ($p < 0.05$). The soil reaction (pH) was affected by SWC and slope gradients ($p < 0.05$), others chemical attributes of the soil under the conserved and unconserved sites were not affected by SWC practices and slope positions ($p < 0.05$) as compared to the other land uses unconserved area. The value of bulk density was highly significant ($p < 0.05$) affected by land uses for maize land and grazing land. The total porosity was highly significant ($p < 0.05$) affected by land uses. The soil pH was significantly ($p < 0.05$) affected by soil water conservation. The soil pH highly significantly (p <

0.05) affected by slope gradients.

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