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Effect of Bench Terreces on Selected Soil Physico Chemical Properties in Andit Tid Watershed, North Shoa, Ethiopia

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Abstract: Land degradation is a major constraint to sustainable agricultural development in Ethiopia. This study was designed to investigate the effect of bench terrace on selected soil physical and chemical properties in Andit Tid watershed, North Shewa Zone. A total of 90 soil samples (2 treatments*3 replication of sample plot *5consecutive terraces* 3 position/zones:-(loss, middle Deposition zone) were collected from 0-20cm depth. Separate soil samples for bulk density determination were collected based on similar sampling design. Results showed that textural fractions of sand and silt (p=0.001), and soil pH (p=0.027) showed significant variation with treatments while variations in clay, SOM, bulk density, and CEC were not significant. Sand fraction was higher in soils under non-terraced while silt and soil pH were higher under terraced farmland. Soil moisture content showed significant variation (p=0.021) with position: higher at the deposition than the rest positions. Although not significant clay, SOM, and CEC values were found to be higher under farmland with terraces than the non-terraced. This indicated that terrace cultivated lands have improved aggregate stability and good moisture content and non terrace cultivated land have low pore space, low water holding capacity and organic matter content than terrace cultivated land. The higher mean moisture content on deposition zone could be related to the downward movement of clay fractions through erosion. Generally, terracing has a remarkable role in improving soil physical and chemical properties. In addition both terraced and non-terraced cultivated land also required integrated SWC measure for better result. Additional research need to be conducted on the effect of soil properties considering other variables like biological measure and other physical structures.

Keywords: Land Degradation, Position, Soil and Water Conservation, Soil Erosion

1. Introduction

1.1. Background

Land degradation is a serious issue throughout the world, particularly in African countries. In Ethiopia, land degradation is serious problem that cause loss of productive soil, crop productivities and economic development of the country [24]. Erosion causes removal of an important nutrient that is essential for fertility, aggregate stability and cation exchange capacity. It reduces the amount of soil on the surface of the cultivated, forest and grazing land that is important for plant to carry out their biotic function. People in the rural areas use animal dung as a source of fuel. These activities may decrease addition of nutrient from animal dung and contributing to the loss of soil fertility [12]. Land degradation is a major constraint to sustainable agricultural development in the Ethiopian high land. Undulating topographic conditions, farming practices that do not consider conservation measure, rainfall characteristics, lack of enough experience and knowledge sharing among the community play a major role in the soil erosion expansion [9].

Inappropriate land use change is one of the major causes of land degradation in Ethiopia. The most productive forestlands have already brought into agricultural production. Ethiopian farmers have been performing agricultural activities for long periods As a result, marginal areas were converted to cultivation and grazing which cause loss or removal of vegetation, grazing lands degradation and soil degradation [36]. In relation with these different studies show that there is substantial miss management of natural resources in the form of over utilizing soil nutrient [10]. [32] discus that the amount of soil loss due to water erosion is estimated about 58% of the total soil loss in the country. Because of this a reduction in agricultural productivity about 2 to 3% per year are reduced and it takes a considerable area of arable land out of production. This situation is dangerous and lead to marginal lands are being cultivated, even on very steep slopes [32].

1.2. Objective of the Study

The general objective of this study is to investigate the impact of long term terrace on soil physical and chemical properties in Andit Tid watershed.

2. Methodology

2.1. Description and Location of the Study Area

Andit Tid watershed is situated 180 km northeast of Addis Ababa close to Debre Birhan. It is located in Basoworena woreda, North Shewa zone, Amhara regional state. Geographically it lies between 9^0 48'N-$9^0$50'N, $39^0$43'E-$39^0$44'E. It covers an area of 481 ha [6]. Its topography ranges from 3000-3500 meters above sea level (m.a.s.l.) (figure 1).

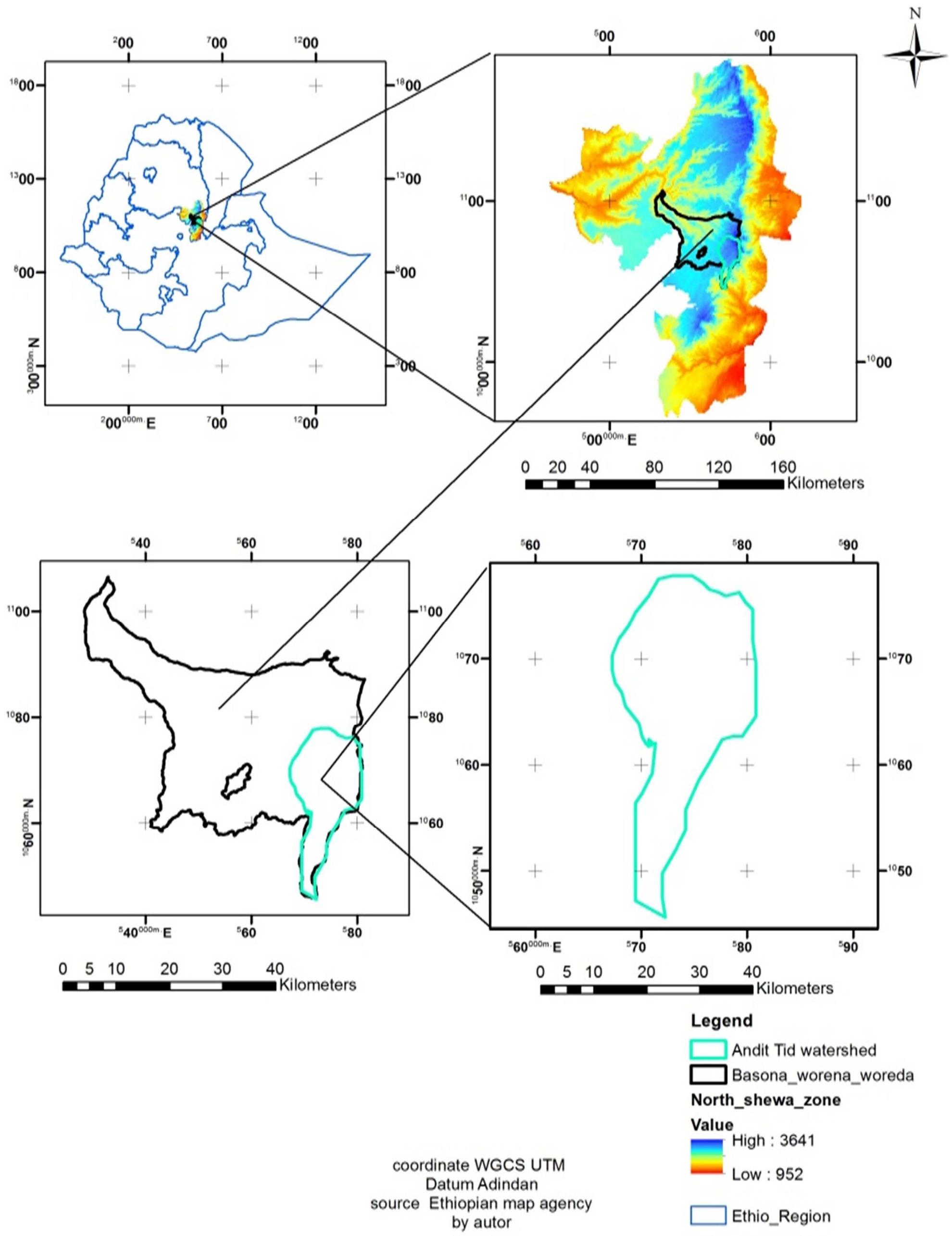

Figure 1. *Location map of Andit tid watershed.*

2.2. Hydrology

Andit Tid watershed has two small rivers, Gudibado and Wadyat, draining the catchment from east to west. Their confluence is approximately 150 m above the gauging station, which is just upstream of the highway bridge crossing of the Hulet Wenz. Based on analysis data over twelve years, the mean annual discharge rate is approximately 720 mm with an annual variation of 36%. Wadyat River is a perennial river, while Gudibado is mostly seasonal. A number of springs emerge during the main rainy season, especially in August when the rainfall is at its peak and the soil fully saturates. However, only a few springs persist for the whole season.

2.2.1. Geology and Soils

The soils in the Andit tid catchment were developed from volcanic rocks. The most important soils in terms of extent and quality are Andosols encompassing 60% of the watershed and found mainly in the upper portion of the watershed. Regosols cover 32% and dominant the lower portion of the catchment. Cambisols (1%), Gleysols and Fluvisols (1%) are minor soil types found in the watershed [6]. Soil depth is apparently related to soil type and varies from 10 - 150 cm. Andosols, fluvisols and cambisols were deeper, while regosols and lithosols were shallow [6]. Regosols are intensively cultivated during the rainy season on the lower portion of the watershed compared to the upper part where fallow periods of five to eight years are practiced [6, 13].

Table 1. *Soil type and cover of Andit Tid watershed.*

	Andosols	Cambisols	Fluvisols	Regosols
Area (ha)	317.46	4.81	2.89	155.84
% cover	66	1.01	0.6	32.4

Source: yohannes, 1989.

Table 2. *Slope class of Andit tid watershed.*

Slope class	Slope%	Class	Area (ha)
1	0-2	Flat	35
2	6-Feb	Gently slope	4.54
3	13-Jun	Sloping	28.82
4	13-25	Moderately steep	50.43
5	25-55	Steep	313.57
6	>55	Very steep	49.04

Source: yohannes, 1989.

2.2.2. Local Climate

Andit tid catchment has a relatively high annual rainfall range from 1300 - 1400 mm and has moist dega agro ecology. During most of the rainy season, the area was foggy due to its location on the edge of the eastern escarpment, where warm air masses rise from the lower plains and condensation begins as soon as the masses reach the colder top of the escarpment [6]. Andit Tid has a bimodal rainfall pattern. The smaller (bega) rainy season is usually from March to May and the main (keremt) rainy season is from July to October. Recently droughts become more common in the area due to increased variability of annual rainfall. However, hail storms and frost are common occurrences and damage crops. Recently, belg rains have become variable. From March to April, monthly rainfall showed high variability from year to year. Temperature has an inverse relation with altitude. It showed that the amount of daily temperature decreases by 1° while for each 100m increase in elevation. In the study area the mean monthly minimum temperature vary from 6°C in December and 12°C in July and the mean monthly maximum temperature range between 15°C on December and 22°C in May.

2.2.3. Land Use and Cropping Pattern

The area covered by protecting shrubs and perennial grasses. About 15% of the catchment is cultivated [38]. Cereal Plough cultivation was the dominant cultivation system in the area and most of the cultivated fields are usually covered with barley, Wheat, linseed, peas and bean mix are the most common crops growing in the area. Because of increasing land pressure, fallow periods are shortened and the fields are given less of a chance to regenerate. These results decreasing yields due to decreasing fertility of the soil, increasing erodibility and ultimately total degradation. The community in the study area perfom conservation farming system in order to maintain the soil from erosion.

2.2.4. Demography

Demographic survey of the study area showed that 439 households are own land out of that 189 household live in the catchment. The total population estimated to be 3500. Size of household varies from 1 to 9.35% of the population in the study area above 8 ages.

3. Methods

3.1. Sampling Site Selection, Soil Sampling and Analysis

In order to take reperesentative sample from the study area reconnissence survey was performed and selecting an area which have similar slope class, soil type, vegetation cover from conserved fam plot select 12 years old bench terrace stracture for sampling. The area between successive bench terrace structures was divided into three zones: loss, middle and deposition. Adjacent to each successive structure within the watershed under similar soil and slope conditions, farmland without any physical SWC structure was identified and samples were collected. All soil samples collected from the top surface (0-20cm). 45 samples were collected from the area treated with terrace (3 replication of sample plots * 3position (loss, middle, deposition) *5 successive structures*1 depth: 0-20cm) using x design [21] from 10*20 rectangular plot sstematically. Similarly, another 45 samples were collected 9 samples from adjacent farmland to each successive structures. The sample site spacing depends on spacing between successive structures. The samples collected from the site were air-dried, mixed well, and pass through a 2 mm sieve for physical and chemical analysis. Separate samples from 0-20cm were collected using a sharp-edged steel cylinder core of 10cm height and 7.2cm diameter for bulk density determination. All soil samples were analyzed in Debereberehan Agricultural Research Center Laboratory. The sample were analysis for soil organic carbon following the [35] methods, Cation exchange capacity (CEC) was determined by extraction method with ammonium acetate and soil pH (H_2O-1:2.5) was determined by potesiometric Methods. Bulk density of undisturbed soil sample was determined by oven drying at 105°C for 24 hours. Soil moisture content was determined by the gravimetric method. Soil texture analysis was performed using Hydrometric method [5].

3.2. Data Analysis

Bench Terrace that was constructed on the study area adjacent control cultivated land, soil zone (position) between Terraces are used as independent variable, and the soil physical and chemical properties were considered as dependent variables. The variations in soil physical and chemical properties due to bench terrace and positions between terrace were tested using SPSS softwere version 20 and using analysis of variance (ANOVA) following General Linear Model (GLM) at P<=0.05 level of significance.

4. Results and Discussion

4.1. Effect of Terrace and Position Between Terrace on Soil Texture, Bulk Density (g/cm^3), Moisture Content

4.1.1. Texture

The analysis carried out for the different treatments regarding the soil fraction revealed that there were statistically significant ($p \leq 0.05$) differences among the treatments in the sand and silt contents. Overall mean value of sand and silt on terraces and non terrace cultivated land were 24.5±1.4%, 30.8±1.4%, (P=0.01) and 38.6±0.75, 34.9±0.75 (p=0.001), respectively (table 3). Clay soil fraction did not significantly vary with treatment but Clay has high value on terrace cultivated land than non terrace one 36.9±1.28, 34.2±1.28, respectively (table 3). The dominancy of sand size fraction on non terrace cultivated land might have resulted from the selective transportation of the fine fractions down the slopes and leaving behind sand size fractions. On terraced cultivated land there were higher value of silt and clay fraction because of agronomic measure like crop rotation and the physical structure. Crop rotation period was maximum one year and the farmer use legume, and other crop interchangeably, so this may have impact on soil aggregate stability and improve soil condition. In addition, on terrace cultivated lands there were grass covers on the bund that improves soil quality, maintain good aggregate stability and may reduce leaching of nutrient. In non terraced cultivated land there was also soil management practice implemented but its effect was not good as terraced cultivated land. As a result, of absence of physical barrier on non terrace cultivated land, fine soil particle was washed out through erosion and coarse particle was left on the area, so the value of sand was higher in non terraced cultivated land which fine particle was removed because of erosion. This indicates that the soil texture is the inherent soil property and soil conservation practices was the main factors which cause the variation in soil texture than soil position. The particle size class of the soil on both treatments was clay loam; it indicates no variations in the parent material. In contrast with the study results [2] stated that since soil weathering is a relatively slow process, texture remains constant and not altered by soil conservation practices.

With respect to the position (zone) between terrace sand, silt and clay did not showed significant variation (P>0.05) But highest mean clay content was observed on deposition zone of terrace cultivated land (38.5±2.22) and the lowest clay content was (35.8±2.22) on loss zone. In contrary to clay content highest mean sand content was found on loss zone. Variation on the textural fraction of soil position and between treatments might be because of soil erosion from the upper part, which fertile soil is moved down and accumulated in the middle and deposition zone and with steep landscapes; transportation and translocation of fine particles are expected.

In line with the above results, [27] also stated that on the steep cultivated hill slope as the slope gradient increases, there was also increased in sand and silt fraction and decrease in clay content. Similarly [11] stated that important nutrient and fine particles are moving downward through leaching because of high precipitation. Furthermore, [29] also discuss that particle size also affected by soil erosion and selective removal of soil particles. The results were in agreement with those reported by [30], who found high amount of clay content at bottom slope and higher sand content at the top slope position. As confirmed by [90] high amount of sand observed at upper slope might be due to a residual quartz grain due to downward clay movement by water erosion. The suspended finer particles transported down the slope due to erosion increase the clay and silt fraction at low slope. According to [14] tillage and water erosion causes fine soil fractions to be deposited in the lower part of fields while the soil profiles are reduced in the upper part. [14] showed that the complete removal of top soil at the loss zone causes the subsoil dominated by clay material while moving down slope and deposited on the top of the fertile deposition zone. Variation may be associated with management practices which resulting directly to the changes in particle size distribution that removed by sheet and rill erosion [33].

4.1.2. Soil Moisture %

Moisture content in terrace cultivated land along the deposition zone showed significant difference than middle and loss zone. Mean value of soil moisture between position were 7.9±0.78, 11.5±0.78, 11.9±0.78 respectively (p=0.021). But, it has no significant variation between treatments. The overall mean value of moisture content of terraced cultivated land was higher than non-terraced cultivated land 10.5±0.44, 9.6±0.44, respectively (table 3). The results revealed that terrace structures significantly improved the soil moisture content between positions. On the embankment of the terrace, there were good grass covers that have high potential to intercept erosive rainfall and increase infiltration. In addition with grass cover soil management practice improve infiltration and down ward movement of water through soil profile. While moving down ward the speed of runoff decrease, the amount of nutrient transported was reduced and the sediment, nutrient and fine particle was settled and deposited on the lower zone due to the presence of well stable bench terrace. Highest moisture content recorded in deposition zone may be because of leaching of important nutrient from the upper part and deposited on lower zone. Because of the above reason terrace can maintain moisture, improve OM, clay accumulation and high infiltration. These activities may be improving soil moisture on terraced cultivated land especially on deposition zone. In line with the study results [3] stated that the amount of soil moisture have significant difference between slope class. It shows that the moisture content of soil in the down slope fields was 6% higher than soils in the mid-slope fields and 15% higher than soils in the up-slope fields. Hence, reduction in soil OM contributes to the loss of grain production and results in food insecurity. Based on slope class the moisture content of the soil is low in high slope and high in lower slope position [15]. [28] conduct research on cultivated land during the period of 2004-2010 and Test soil and water conservation techniques cover crescent bunds, coconut husk burial, reverse (back slope) terraces, catch pits and contour plot without any manner of conservation. The result of soil moisture on area which cover with terrace classified in to three soil depth class (0-30 cm, 30-60 cm and 60-90 cm) was equal to 14.6% and soil moisture for non conserved was 11.6%. [39] also discussed that the soil profile in a terrace can be grouped into three layers: the fast changing layer, activity layer, and relatively stable layer. In the fast changing layer of a terrace water store and could be 7.2% higher than non-terraced land.

Table 3. *Mean value of selected soil physical properties (soil texture, Bd (g/cm^3), moisture%).*

Physical Properties of topsoil (0–20 cm depth); Soil Texture (sand, silt, clay,%), Bd (g/cm^3) and moisture%on terrace and non-terrace plot with in position between terrace (mean ±S.E.)									
Physical properties	**Treatment (terrace)**				**without Treatment (non terrace)**				**P value**
	Loss	**Middle**	**Deposition**	**Overall Class**	**Loss**	**Middle**	**Deposition**	**Overall**	
sand%	25.9±2.42	23.9±2.42	23.7±2.46	24.5±1.4^A	31.3±2.42	31.1±2.42	30.1±2.42	30.8±1.4^B	0.001
silt%	39.8±1.31	37.9±1.31	38.1±1.31	38.6±0.75^A	35.7±1.31	35.1±1.31	34±1.31	34.9±0.75^B	0.001
clay%	35.8±2.22	36.5±2.22	38.5±2.22	36.9±1.28^A	33.6±2.22	34.9±2.22	34.9±2.22	34.5±1.28^A	
BD g/cm^3	0.68±0.39	0.67±0.39	0.64±0.39	0.67±0.02^A	0.68±0.39	0.74±0.39	0.62±0.39	0.68±0.02^A	
moisture%	7.96±0.78^a	11.56±0.78^a	11.88±0.78^b	10.47±0.44^A	9.3±0.78	9.69±0.78	9.84±0.78	9.61±0.44^A	0.021
Overall mean value in row label by different latter are significant difference at p<0.05 in relation to those treatment and position between terrace.									

Table 4. *Mean value of selected soil chemical properties (soil P^H, SOM%, CECmg/mol).*

Soil Chemical Properties of topsoil (0–20 cm depth); soil PH (H_2O), SOM% and CEC mg/mol on terrace and non-terrace plot within positions between terraces (mean ±S.E.)									
Chemical properties	**Treatment (terrace)**				**Without Treatment (without terrace)**				**P-value**
	Loss	**Middle**	**Deposition**	**Over all**	**Loss**	**Middle**	**Deposition**	**Over all**	
PH	6.51±0.05	6.64±0.05	6.65±0.05	6.6±0.31^A	6.55±0.05	6.53±0.05	6.43±0.05	6.5±0.31^B	0.027
SOM	1.91±0.25	1.92±0.25	2.34±0.25	2.08±0.14^A	1.90±0.25	1.91±0.25	2.08±0.25	1.97±0.14^A	
CEC	33.7±2.1	34±2.1	35.9±2.1	34.5±1.2^A	34±2.1	33.3±2.1	35.5±2.1	34.2±1.2^A	
Overall mean value in the row label by different latter are significant difference at p<0.05 in relation to those Treatment and position between terraces.									

4.1.3. Bulk Density g/cm^3

The soil bulk density of the study area was not significantly affected by the soil conservation practices and soil position. Overall, mean value of bulk density on terraced cultivated land was lower than non terraced cultivated land 0.67±0.02 and 0.68±0.02, respectively on (table 3). The result showed that as moving from loss to deposition zone between successive structure speed of runoff decrease, the amount of soil OM increase. OM accumulation and clay dominating soil existence cause decrease BD (table 3).

Areas treated with bench terrace recorded lower mean value of BD compared to non-terraced cultivated land. Increase in BD on non conserved farm plots to be associated with soil compaction due to removal of top soil, which has implications for the moisture and air that would be available to plant root and microorganisms in the soil system. On non terrace cultivated land the area was more prawn for animal grazing because of this the soil was more compacted, less infiltration and have high soil bulk density. The finding of the study showed that soil bulk density declined as soil moisture content increased along the soil position. This is in line with finding of [17] point out that soil bulk density on conserved cultivated land has lower value than non-conserved cultivated land. Similarly, [20] also reported that the bulk density on gentle slope is lower than the steep or higher slope gradients. Soil compactness, measurement of soil structure, calculation of soil pore space, water content determine, based on soil bulk density [4]. Bulk density can also be changed by management practices that affect soil cover, organic matter, soil structure, compaction, and porosity [31].

Study conducted in Laely maychew by [34] also found relatively higher (1.5 gm/cm^3) average bulk density on unbunded farm land plots compared to average bulk density (1.38 gm/cm^3) for the bunded farm plots considered on average ground slopes of 3%, 8% and 13%. Bulk density also provides information on the environment available to soil microorganisms. Similarly [23] stated that the mean value of bulk density on the conserved micro watershed have lower value compared with non conserved micro watershed this show more roots of plants, higher organic matter and sediment are accumulated in this zone of the micro watershed.

4.2. Effect of Terrace and Position Between Terrace on Soil pH, SOM%, CEC cmol/kg

4.2.1. Soil p^H

P^H has no significance difference between soil positions. The overall mean value of P^H was low on non-terraced cultivated land than terraced. It showed significant difference between treatment 6.6±0.31 and 6.5±0.31 p=0.027, respectively (table 4). It indicated that non-terraces cultivated land is more acidic than terraces cultivated land and significant variation in soil pH with treatment might be associated with loss of basic cations trough erosion and leaching as well as low ground cover in non terraced cultivated land than terraced one. Terrace increase the soil p^H due to trapping of sediment contains basic cataion and improvement of ground cover that ultimately improve soil quality. [7] indicated that soil pH have significantly differed between treatment which was in agreement with results of this study. This result was also similar with Anjeni watershed, which reported by [1] that during the rainy season the rainfall has an erosive force that causes leaching of nutrient that was important for plants. Similarly, as excess rainfall passes through the soil, there could be leaching of basic nutrients like calcium and magnesium. Thus, these nutrients will be replaced by acidic elements including hydrogen and aluminum. Because of such condition, there will be an increase in the acidity of the soils [25]. In tropical area because of erosive rainfall the amount and distribution of K^+, Ca^{2+} and Mg^{2+} are low which was mentioned by [23]. The result also agrees with that of [27] who reported that the higher amount of soil loss due to erosion might have removed the topsoil and exposed the subsoil to the surface resulting in lower pH in non conserved land. [8] also indicated that soil in steeper slope had significantly lower pH value than those in the gentle and moderate slope positions due to the accumulation of soluble cations on the gentle slopes. In general, the amount of soil P^H was low in non-terraced cultivated land compared with terraced cultivated land because of leaching of nutrient, cation.

4.2.2. Soil Organic Matter (SOM)

SOM did not have significant difference between treatment and soil position which is p>0.05 (table 4). The overall mean value of organic matter between terraced and non-terraced cultivated land was 2.34±0.14, 1.97±014, respectively and mean value on soil postion was (1.91±0.05, 1.92±0.05, 2.34±0.05) on terraced cultivated land respectively. The mean values of terrace cultivated land were higher than non terrace cultivated land. Non significant difference between treatments on soil organic matter may be due to current tillage system. That mean non terraced cultivated land was fallow land and this may have good soil organic matter in comparable with terraced cultivated land. Crop residue on the soil surface over the years under this system will increase the amount of organic material, especially carbon in the soil. In addition, Soil organic matter changes with the soil tillage management and types of tillage systems in which much more crop residue returns to the soil, and it affects soil organic matter in an extended range. The variation also due to agronomic measure that was implemented on the area in order to increase soil productivity. Terraced cultivated land was covered by legume and short crop rotation period than non terrace cultivated land. Moreovere, the area above the cultivated land was treated well and cover by grass so there was addition of crop residue, leaves and may improve soil OM. In relation with that, there was also higher mean value on deposition zone than loss and middle zone on terraced cultivated land due to high accumulation of organic matter that comes from the loss zone through erosion. Nutrient and organic matter that found in the loss and middle zone ware leached out through runoff cause variation in different soil properties like moisture and nutrient availability within the inter-terrace space. Soils at down position would have received greater amounts of organic material, although potentially experiencing faster rates of decomposition, assuming moisture content at or near field capacity. Upper position had higher slope gradients, which likely decreased the rate of water infiltration, thereby limiting the depth of soil formation. Moreover, on terraced cultivated land, especially on deposition zone there was good grass and shrub cover so dead leaf and letters also increase the amount of soil organic matter. Terrace also change the steepness and decrease erosion, this may be attributed to accumulate and retained OM due to terrace construction, whereas the lowest OM may be attributed to the loss in the form of decaying leaves, stems and roots from surface soil due to lack of physical structure that control downward movement of nutrient.

In line with that a study conducted by [19] in the Amhara region, Enebsie Sar Mider woreda, also point out that the OM content of non conserved land for a slope range between 10 and 15% were lower (mean = 1.12%) than the conserved land of corresponding slope class (mean=2.33%). Soil OM content was the highest value at lower positions for conserved farm plots that directly related to higher amount of available soil MC. Upper positions had the lowest OM that may indicate the severity of soil erosion on these sites and transportation to the low point in the landscape through runoff. Moreover, [37] reported that the non-conserved fields had significantly lower SOM as compared to the conserved fields with SWC measures.

According to, [23] the percentage of soil organic matter in the conserved area was greater than that of non-conserved area. Similarly [19] reported that the organic matter content of terraced land between 10 and 15% slope class (mean = 2.33%) has higher mean value than non-conserved land (mean =1.12%). Moreover, [7] also reported that Organic matter content mainly high in the lower side of the slope because of the lower slope class has higher moisture content than the loss and middle zone. In contrast with the study result [22] explain that there was significant difference between terraced and non-terraced cultivated land. The siginificant difference may be due to others factors like biological and agronomic measure. In addition, with that area that treated with terrace serve as a sink of carbon.

4.2.3. CEC (Cataion Exchenge Capacity)

The overall mean value of CEC was not significant ($p > 0.05$) with respect to treatment and position between terraces. The mean CEC value was higher in the conserved land than non terraced cultivated land (Table 3). The overall mean CEC (cmolc/kg) value in the study area was (34.6 ± 2.1) and (34.2 ± 2.1) on terraced and non-terraced cultivated land respectively. In terraced cultivated land due to high OC and the presence of terrace the soil fraction was more dominantly clay and silt so that the particle would have good Cation. As a result of For this they can attract hold and release positively charged nutrient particles (cations). But in case of non terraced cultivated land the area was more prawn for erosion and the fine particles were washed by water erosion and its amount was low. Because of this the area was dominated by sand soil fraction that have low cation. The result showed that improving soil OM content can increase soil CEC. High clay fraction along with soil OM may also attribute to high rate of soil CEC. Therefore, processes that affect soil OM due to soil erosion, intensive cultivation can affect CEC of the soil [11]. which in turn affects soil fertility and can cause loss of soil productivity. The study finding also in agrement with that of [9] who reported that the surface soils of the cultivated land treated with terrace have high CEC than non terrace cultivated land. CEC of a soil is strongly affected by the amount and type of clay and amount of OM present in the soil. Similarly, a high clay soils could hold more exchangeable cations than a low clay soils. According to Landon (1991) the top soil having CEC of > 25, 15-25, 5-15 and < 5 Cmol kg^{-1} are classified as high, medium, low and very low, respectively. Both clay and OM were negatively charged and act as anions. As a result, these two materials, either individually or combined as a clay-humus complex, have the ability to absorb and hold positively charged cations.

5. Conclusions and Recommendation

Physical soil and water conservation measure that applied in erosion prone areas like Andit Tid catchment have a significant role in the improvement of selected soil properties through reducing soil erosion and nutrient loss. In the study area, terrace is one of the physical structures implemented in the catchment through community based participatory watershed management. This has a positive impact on different soil physical and chemical properties.

The results regarding the soil fraction and moisture content revealed that there were statistically significant differences among the treatments in the sand, silt, and between position on moisture contents and in the soil's P^H as well. Terraced cultivated land had the highest mean percent silt content and the lowest mean sand percent, which were significantly different between treatments. The result showed that terrace can affect and improve soil properties.

On terraced cultivated land, soil moisture also show significant variation between soil positions. It has high mean value on deposition zone than loss and middle. Organic matter, silt%, clay%, moisture%, CEC have higher values on terraced cultivation land than non terraced cultivated land, as a result of existeing well developed terrace in the area. Moisture content between soil position like (loss, middle, and deposition) zone also increase downward, which have a positive impact on terraced cultivated land. It indicates the effectiveness of a terrace on improving soil properties, water infiltration capacity and quality.

Soil pH is one of the most important parameters considered in the soil fertility evaluation, while soil organic matter (OM) is important in determining soil quality. Generally, soil pH values of the terraced cultivated land varied from weakly acidic to nearly neutral. The analysis of variance revealed statistically significant pH differences among the treatments considered in the study. In case of sand% and BD have high value on non-terraced cultivated land because of low OM and high leaching on the area that's important and fine particle are removed and cause low pore space.

Generally, the soil condition related to physical and chemical properties terraced cultivated land has better condition than none terraced one. In case of soil position, most soil properties have better conditions of the deposition zone than loss and middle zone. It indicated that construction of bench terrace have a great role not only protecting the mass movement of soil but also reduces nutrient depletion and improve soil physical and chemical properties.

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Conflicts of Interest

The authors declare no conflicts of interest.

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