American Journal of Water Science and Engineering
2022; 8(3): 52-60
http://www.sciencepublishinggroup.com/j/ajwse
doi: 10.11648/j.ajwse.20220803.11
ISSN: 2575-1867 (Print); ISSN: 2575-1875 (Online)

Effects of Desho and Vetiver Grass Strips on Selected Soil Physical and Chemical Properties: The Case of Kasha Watershed, Southwest Ethiopia

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To cite this article:
Mohammednur Tuji, Awdenegest Moges. Effects of Desho and Vetiver Grass Strips on Selected Soil Physical and Chemical Properties: The Case of Kasha Watershed, Southwest Ethiopia. *American Journal of Water Science and Engineering*. Vol. 8, No. 3, 2022, pp. 52-60.
doi: 10.11648/j.ajwse.20220803.11

Received: June 6, 2022; **Accepted**: July 14, 2022; **Published**: July 28, 2022

Abstract: Land degradation is the critical ecological and agricultural challenges in Ethiopia. The study were conducted in Kasha watershed, in southwestern Ethiopia to evaluate effect of Desho and Vetiver grass on selected soil physico-chemical property. Land treated with Desho and Vetiver grass and untreated adjacent control land were evaluated under gentle slope (3-15%) and moderately steep slope (15-30). 18 soil samples were collected from the top 20 cm soil depth with three replications. Selected soil properties were analyzed in a laboratory, the results were then interpreted for differences and significant changes using the statistical software SAS. The results showed that soil Bulk density (Bd), soil moisture content (MC), soil pH, soil organic matter (SOM), total nitrogen (TN) available phosphorous (Av.P) and cation exchange capacity (CEC) were significantly ($p \leq 0.05$) different on land treated by Desho and Vetiver grass strips as compared to the untreated adjacent control plots. Variations under the different slope gradients were also significantly different. Soil texture was not significantly ($p \leq 0.05$) differences between the conserved and un-conserved lands but significant difference with respect to slope gradient. SOM content was positively correlated to soil pH ($r = 0.894$), TN ($r = 0.985$), Av.P ($r = 0.892$), and CEC ($r = 0.916$) but inversely correlated to Bd ($r = -0.806$). Desho and Vetiver grass have proved to be effective for improving soil properties; this perhaps is due to minimizing erosion. They are promising interventions of soil and water conservation for their multiple purpose Integrated physical and biological soil and water conservation measure could benefit farmers to reducing erosion, improve fertility and enhance production of crops in agricultural farms.

Keywords: Desho Grass, Kasha Watershed, Soil Fertility, Vetiver Grass

1. Introduction

Soil is a medium that supports the germination, growth and maturation of plants in combination with other life support systems and improves yields. The well-being of current and future generations depends on soil fertility in agricultural countries such as Ethiopia [22].

Land degradation is the main environmental problem throughout sub-Saharan Africa, and Ethiopia is one of the most affected countries [5].

Highly productive lands in southern Ethiopia are exposed to decline due to overfishing of land resources to survive [11]. Soil erosion is one of the major shape of land degradation. It affects the physical, chemical and biological properties of the soil, leading to on-site nutrient loss and off-site deposition of water resources [16].

Agriculture is not only business-related endeavor but also further a lifestyle in Ethiopia and land is a main source for building money in people. The livelihoods of the most public rely upon straight forwardly or indirectly on this subdivision. It abstain from food proverb that aforementioned reliance definitely leads to an increase in the vulnerability of the saving to questions of land deterioration [33] and in Ethiopia highlands soil erosion very high [14].

Identifying land degradation as a major environmental and socio-economic problem, the governments of Ethiopia and

NGOs have intervened to alleviate the problem. To combat land depravity at a communal level, tangible conservation and land restoration exertion was begun in 1970s, to combat land deterioration at a national level, material preservation and land restoration exercise was begun in 1970s.

As a result, large regions have happened terraced utilizing soil bunds or different physical wealth, covered by area closures and cultivated disgraced lands with forest seedlings. Nevertheless, the successes have existed far beneath expectations. The country still avoids a many of productive soil and the danger of land degradation is broadening severely [31].

Biological soil and water conservation practices are intensifying the overall soil wellness; develop soil organic matter content, material features and food situation. Further, it is smart and economical than physical constructions, benevolent to improvement lands, protect land from further depravity, and secure physical fundamental for long period of time [4].

The Study site, was selected purposely because of presence of biological soil conservation practice; farmlands conserved using Desho grass and Vetiver grass strips. According to Bench Sheko zonal bureau of agriculture part of Kasha watershed, is subjected to the rehabilitation with Desho and Vetiver grass strips since 2014. The restoration practices are executed by SLM (Sustainable Land Management project) together with local peasants and management to raise the atmosphere and build up food insurance.

Desho and Vetiver grass strips are the most widely practiced intervention in the study area, so that farmers use Desho and Vetiver grass strip to protect their cropland from erosion moreover, they focused on the potential value of the grass as a source for livestock feed.

Increasing pressure on agricultural land were the major threats to soil fertility management in the study catchment. However, sustainable soil management technologies and practices, which have been supported by research finding, on effects of these interventions (Desho and Vetiver grass strips) to keep soil fertility, and apart from monitoring and evaluation reports, no substantive studies made on their performances of improving both physical and chemical soil properties so far and gap transferred to farming communities in the study area. Investigation on the effect of Desho and Vetiver grass strips to improve soil physical and chemical properties is important. Such work is also, useful in similar agro-ecological zone in the country. Therefore, this study aims to evaluate the effect of Desho and Vetiver grass strips on selected soil physical and chemical properties under different slope gradients in Kasha watershed.

2. Materials and Methods

2.1. Description of the Study Site

2.1.1. Location

The study area is found in Semen Bench woreda, Bench Sheko zone in southwestern part of Ethiopia, about 583km southwest of Addis Ababa and 819 km from Hawassa. Geographically, it is located between 6.74°-7.21°N Latitude and 35.57°-35.75°E Longitude (Figure 1). In Semen bench woreda there are 23 kebeles with administrative town of Temenjayaj. Some of these kebeles are newly emerged by splitting larger kebeles due to population growth and for management purpose.

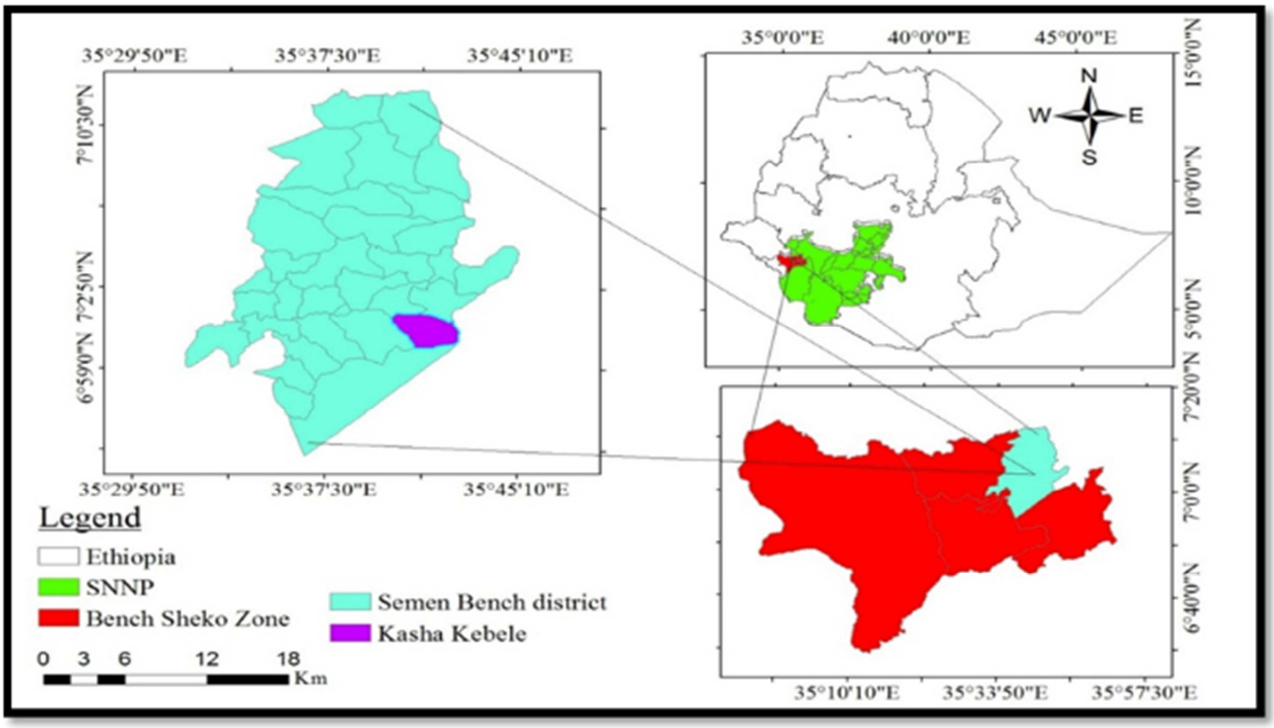

Figure 1. *Location map of the study area.*

2.1.2. Topography, Soil Type and Climate

The Ethiopian climate condition is determined by altitude [12]. The same is true, that large part of Semen Bench woreda is characterized by rugged topography that consists very high mountains; deeply incise canyons, gorges, valley, plain and plateaus. About 3% of estimated area is Dega, 95% of the total area is Weyna dega, and the remains 2% is Kola. However, the climate under condition slightly varies from rural kebele to kebele, due to a difference in the nature of relief (Topography).

Topographically Semen Bench Woreda altitude ranges from 1001-2500m above mean sea level. The soil type is dominated by Alisols with stony phase and sandy clay [19]. The study area has a mean annual minimum and maximum temperatures of 15.1°C and 25.1°C, respectively and the annual rainfall range from 1694.5 to 2252mm which is characterized by one long summer and one short spring rainy season The rainfall pattern of these areas is characterized by bimodal distribution with small rainy season belg (March-June) and main rainy season Kermit.

2.1.3. Crop Production and Economy

The livelihood of the community is mainly based on mixed farming system. The dominant crops in the study are:-cereal crops (26%) Maize (*Zea mays*) barley (*Hordeum vulgare*), wheat (*Triticum spp.),* Teff (*Eragrostis teff*), Sorghum (*Sorghum bicolor*), Rice (*Oryze stiva*), Sesame (*Sesamum indicum*), faba beans **(***Vicia faba***)**, and Common bean (*Phaseolus vulgare*), Tree crops (65%), like Coffee (*Coffee arabica*), Mango (*Mangifera indica*), Banana (*Musapara disiacavar. sapiertum*), potato (*Solanum tuberosum*) and Avocado (*Persea americana*) root and tuber crops (9%) potato (*solanumtu berosum*), sweetpotato (*Ipomoea batatas*), Carrot (*Daucus carota subsp. sativus*), Inset (*ventricosum*), Taro (*Colocasia esculenta*) (Bench Sheko zonal agricultural office, 2012).

Livestock production plays a significant role in the livelihoods of the people in the study area. Livestock is also a source of foods and cash as well as the major source of draft power, fuel and fertilizer for crop production. The common types of livestock in the area include cattle, sheep, and poultry.

2.1.4. Soil Erosion and Conservation Practices

Soil erosion is one of the major problems in the area. Since, the area received high rainfall, sheet and rill erosion are common types of erosion and in some areas gullies also observed.

The other reasons that facilitated soil erosion are continuous cropping, burning of crop residue, less attention for biological soil conservation practices, and lack of model watershed and different soil conservation measures for demonstration. Expansion of agricultural lands on sloppy land without physical and biological conservation practices is also reported as cause of soil erosion and landslide. Less integration of soil and water conservation practices with agro forestry practices is also another problem [26].

In order to reduce the aforementioned problems farmers practice different biological and physical soil and water conservation measures. Planting of multipurpose plant species like Vetiver grass, Desho grass, Banana, Inset, Mango, Avocado, and Taro on the physical measures are some measures practiced by the farming community. Physical soil and water conservation practice like Soil bund, Fanya juu, Bench terrace, Cutoff drains, and waterways were practiced by farmers [26].

2.2. Methods of Soil Sampling and Analysis

2.2.1. Soil Sampling and Data Collection Methods

A preliminary field observation was carried out to identify representative soil sampling plots were identified through direct observation and transect walk for representative composite sample per treatment.

During the observation, parameters that were expected to lead for variability of soil fertility, mainly soil, water conservation practice, and slope gradient were recorded.

The study district was first demarcated rested on slope gradient. Slope and elevations of the study area were measured by using clinometers and global positioning system (GPS), respectively. The SWC practice availed in between 3-30% slope range in the study area; accordingly the slope gradient was divided in to two slope ranges: 3-15% is considered as gentle slope and 15-30% as moderate slope [8].

The experimental had six treatments: Desho grass + gentle slope (< 15%); Desho grass + moderate slope (15-30%); Vetiver grass + gentle slope (< 15%); Vetiver grass + moderate slope (15-30%); adjacent control land + gentle slope (< 15) and adjacent control land + moderate slope (15-30%). In farm plots where Desho and Vetiver grass strips were practiced (conserved) plots following the slope ranges, soil samples were taken between the two successive SWC practices and in the case of the adjacent control land (non-conserved) plots, soil samples were taken with recommended interval /distance from conserved plots of farm land following slope ranges. To keep similarity among treatment except the management practices (Desho and Vetiver grass strips) of five year age, all conditions (Crop type, vegetation cover, slope, soil, climate, and topography closeness to each other) were similar across the farm land from which soil samples were collected for laboratory test.

To evaluate the effect of Desho and Vetiver grass strips on soil properties, composite soil samples was randomly collected (0–20 cm soil depth) at four corners and center of a plot of 10m x 10m size using ”X” sampling design with sharp edged auger drilled manually down the soil profile. A total of 18 composite soil samples (3treatment * 3 replication * 2slope) were taken for soil property analysis.

The samples collected at the sampling point were mixed thoroughly in a plastic bucket to form a composite sample. Collected soil samples put forth on electronic media-drained at room temperature, homogenize and gone through a 2mm sieve before laboratory study. Moreover, undisturbed samples were taken with a core sampler of height 10cm and diameter 7.2cm for soil bulk density determination. Similarly, undisturbed soil samples were collected from each land applying core-sampler to choose soil bulk density. Except the soil bulk density which was determined at Tepi soil laboratory, for the rest parameters, collected samples were handled in plastic bags, labeled and transported to Malkesa agricultural research center for soil physico- chemical properties for analysis using the standard procedures.

2.2.2. Soil Laboratory Procedure

The surface soil samples collected from the study area was air dried, crushed and sieved to pass through 2 mm sieve for the analysis of pH, particle size distribution, CEC, exchangeable cation and available P and through 2 mm sieve for the determinations of organic matter and total nitrogen. Particle size distribution were analyzed by the modified Bouyoucos hydrometer method Bouyoucos, G. J., [7] using sodiumhexametaphasphate as dispersing agent.

Soil Bulk density was estimated from undisturbed soil samples collected using core sampler [1, 4, 5], and the relationship is: Bulk density (gcm^3) = Oven dry soil mass (g)/Core volume (cm^3). Soil Moisture Content and bulk density of undisturbed soil sample was determined by core method) [9], using the ratio of solid mass to total volume when the sample was dried in an oven at 105°C for 24hrs.

Chemical property (Total Nitrogen (TN), Available Phosphorus (AP), Cation Exchange Capacity (CEC), Soil Reaction (pH), and Soil Organic matter, was analyzed following standard laboratory procedure. Soil organic carbon (SOC) was determined by the Walkley-Black oxidation method, Total nitrogen (TN) was determined using the Kjeldahl digestion method, and Available Phosphorous (Av-P) was determined using Olsen's extraction method, The Cation Exchange Capacity (CEC) was determined by extraction with Ammonium acetate method, and soil pH was determined by potesiometric Methods at a 1:2.5 soil-to water ratio After 30 min of stirring, the pH was measured in the suspension by using standard pH meter as described by Sahlemedhin, S. and B. Taye [27].

2.3. Statistical Analysis

Soil and water conservation practice (Desho and Vetiver grass strips) of five year age and adjacent control farmland plots and slope gradient were used as independent variables and the soil parameters as dependent variables. The significance difference of soil property due to SWC practice and adjacent control farm land were tested using analysis of variance (ANOVA) using SAS, 9.1. The general Linear Model (GLM) procedure at $P \leq 0.05$ level of significance used to test and to quantify some correlations between soil properties.

3. Results and Discussion

Effect on Soil texture

Based on USDA (1987) soil textural triangle, the soils textural classes of all experimental farmlands was clay loam. The results of soil physical properties analyses are presented in (Table 1). There was no significant variation ($p < 0.05$) with respect to conservation treatment in the soil textural fractions of sand, silt and clay. The non-significant difference in texture may be due to the inherent soil property, acidic nature of soil and low decomposition that cannot make significant change on weathering then biological soil conservation practice Mulugeta, D. and S. Karl [24]. Since, soil weathering is a relatively slow process, texture remains fairly constant and is not altered by soil conservation practices.

The soil textural fractions of sand and clay showed significant variation with slope gradient (P=0.001) and (P=0.0001) respectively.

The mean sand content was higher (35.67±1.09) and lower (32.11±1.17) when the slope gradient was greater than 15% and 3-15%, respectively (Table 1).

Sandy soil increase with slope gradient while clay and silt soil decreased with slope gradient, this may be due to fine textured nature of soil and erosion effect transport fine particle from upper slope to lower slope position. This is confirmed with the study conducted by Mulat, G., et al [23] sand content increases as slope gradient increases, and clay and silt content decreases as slope gradient increases.

Effect on soil bulk density

The soil bulk density showed statistically significant variation (P=0.0007) with treatments and (P=0.00041) with respect to slope gradients. The higher mean soil bulk density value was observed in control farmland compared to the conserved farmlands. The farmlands conserved with stabilized Desho and Vetiver grass strips has a lower mean soil bulk density value than the non-conserved farmland. The lower mean soil bulk density value under SWC measures might be the subsequent effects of reduced soil loss and crop residue through erosion; and addition of organic matter from the Desho and Vetiver grass strips especially for integrated measures.

The overall highest mean average value of soil bulk density (1.24±0.01g/cm^3) was observed at un-conserved adjacent control farmland. The presence of higher soil bulk density may be because of soil compaction, livestock trampling and removal of organic material from upslope or vegetation via grazing, and soil erosion. Similar finding by Mulugeta, D. and S. Karl [24] also reported that, soil under non-conserved treatment was found to exhibit higher soil bulk density than treatments by SWC structures. The lowest mean average value (0.95 ±0.04g/cm^3) was at farmland conserved with Desho grass strips at gentle slope and followed by Vetiver grass strips at gentle slope. This could be due to Desho and Vetiver grass strips had strong root systems cause more porosity and therefore lower soil bulk density (Table 1).

The soil bulk density also showed significant difference (P=0.00041) with the slope gradients. The results indicate that soil Bd has a direct relation with slope gradient that might be attributed to the corresponding decline in soil organic carbon content with the increase in slope gradient/steepness. Report in agreement by Mathewos, B., L. Mulugeta, and R. Alemayehu and Mulugeta, D. and S. Karl [21, 24] also indicated that, decrease in soil bulk density on cultivated soils in the lower than in the higher slope gradients. Additionally, the achieved soil bulk density improvement is due to soil organic matter addition from the plants, reduction of physical soil loss, and exclusion of grazing practices and human interference. Li, et al. Also agreed that, the soil bulk density on gentle slope is lower than in the steep or higher slope gradients [18].

Table 1. *Soil Physical Properties of topsoil (0–20 cm depth); Soil Texture (sand, silt, clay, %), Bd (g/cm³) and Mc at Two slope Gradients under the Three Treatments (mean ±S.E.).*

Variable	Slope gradient (%)	Conservation practice			overall
		Desho grass	Vetiver grass	control	
Sand (%)	<15%	33.00±2.02b	31.33±1.65b	32.00±1.33b	32.11±1.17b
	15-30	36.00±2.02a	35.67±2.50a	35.33±1.20a	35.67±1.09a
	overall	34.50±1.25a	33.5±1.33a	33.67±0.85a	
Silt (%)	<15%	31.33±1.45a	32.67±1.03a	32.67±2.40a	32.22±1.51a
	15-30	32.33±0.88a	31.33±7.00a	32.00±1.52a	31.89±2.03a
	Overall	31.83±1.95a	32.00±0.84a	32.22±1.27a	
Clay (%)	<15%	35.67±2.08a	36.00±1.03a	35.33±2.40a	35.67±1.02a
	15-30	31.67±2.08b	33.00±4.50b	32.67±0.33b	32.44±1.48b
	Overall	33.67±1.34a	34.50±1.31a	34.11±1.17a	
Bd (g/cm³)	<15%	0.84±0.08c	0.99±0.04b	1.22±0.01a	1.02±0.05b
	15-30	1.06±0.08b	1.17±0.11a	1.25±0.03a	1.16±0.05a
	Overall	0.95±0.04c	1.08±0.05b	1.24±0.01a	
Mc (%)	<15%	19.34±1.14a	17.57±1.23a	13.47±0.33c	16.79±0.96a
	15-30	15.81±1.19b	14.81±1.51bc	12.79±0.33c	14.47±0.75b
	Overall	17.57±0.88a	16.19±0.97b	13.13±0.25c	

Note: - Means within rows followed by different letters are significantly different ($p < 0.05$) with respect to treatment and slope gradient.

Effect on Soil Moisture content

The results of the ANOVA indicated that there is significant difference (P=0.0001) in soil moisture content between the treatments (Desho and Vetiver grass strips) and adjacent control farmland. Statistically the overall higher mean average value of soil MC (17.57±0.88%) was observed in farmland conserved with Desho grass strips found at gentle slope, followed by Vetiver grass strips found at gentle slope and the lowest MC (13.13±0.25) was observed in un-conserved adjacent control farmland found at moderate slope followed by adjacent control farm land found at gentle slope (Table 1). This could be due to, the grass strips conserve moisture through impeding runoff, the root systems and cover minimizing evaporation.

On the other hand runoff generation increased with increasing slope gradient in addition to being captured by Desho and Vetiver grass strips. Other finding agree that effect of vetiver grass strips increase soil moisture storage by a range of 1.9% to 50.1% at various slope and soil depths [6].

The overall highest mean average value of soil moisture content is observed in gentle slope position <15% (16.79±0.96) then moderate slope position of 15-30% (14.47 ± 0.75). This might be due to the fertile topsoil moved down the slope by water erosion processes, sediment deposition took place at gentle slope positions, which in turn might have contributed to increased soil depth, and infiltration consequently improved the water content of the soil and improves soil cover, moisture retention and fertility. Similar to the results on the soil MC, [3] on their report also confirmed that soils that lie at the middle and lower positions receive more moisture than upper slope.

The role of Desho and Vetiver grass strips might also the grass's nature form a hedge that is very effective in slowing and spreading runoff water, reducing, conserving soil moisture and trapping sediment and farm chemicals on site. (e.g., root system) and diverse roles (erosion control, land rehabilitation, feed for cattle), restoring degradation of land through storing sediment, hold water and enhancing the water holding capacity of a soil, therefor Desho and vetiver grass strips hedge is probably widely used for improvement of soil fertility and land management practices. This indicated that Desho and Vetiver grass strips in farmland had boundless potential for soil and water conservation, and improve soil physical property. Similar report showed by Abiy, T. and Getahun, and Y., et al. reported that, Desho grass is among the most desirable one to control erosion and rehabilitate degraded land and [30] Vetiver grass strips amazing grass used to control erosion, slow and conserve moisture [5, 13]. Other author report shows that, the higher moisture content of soil from vetiver grass farmland might be due to the fact that the Vetiver grass hedges slowed most desirable one to control erosion and rehabilitate degraded land and [30] Vetiver grass strips amazing grass used to control erosion, slow and conserve moisture.

Effect on Soil pH, SOM, TN, Av-P, and CEC

Soil pH showed statistically significant variation (P=0.00017) with respect to treatments and slope gradients (P=0.0004) and their interaction effect (P=0.0384). Soil pH was higher (5.72±0.12)) in farmland conserved with Desho grass and lower in un-conserved farmland (5.12±0.16) (Table 2). This variation might be due to leaching of cations in controlled farm plot due to absence of SWC practice that trap soil as well as low ground cover in the farm as compared to the conserved farm plot. Soil pH was lower in slope >15%

(5.32±0.15) and higher in 3-15% (5.68±0.13) slope. This could be due to the fact that the high rainfall coupled with steeper slopes might have increased leaching, soil erosion and a reduction in soluble base cations leading to higher H+ activity and registered as decreased pH.

Desho and vetiver grass conservation practice have significant effect on soil pH compared to un-conserved farmland. Similar report by Hailu, K. and Y. Melese indicated that low pH values in the untreated fields due to the low base saturation percentage and low sediment organic matter (SOM) content and high pH value in the sediment accumulation zone behind the SWCPs of the treated fields [15]. Based on Tekalign, M. and I. Haque [29] soil acidity rating criteria, soils in study area conserved by biological SWC practice (Desho and Vetiver grass strips) were rating as moderately acidic while un-conserved adjacent control land is rating as strongly acidic.

Soil organic Matter (SOM) significantly varied within treatments (P=0.0002), slope gradients (P=0.0001) and their interaction effect (P=0.0340).

The maximum mean average value of soil organic matter (SOM) (3.05±0.21) observed in conserved farmland with Desho grass and the lowest mean average of soil organic matter (SOM) (1.88±0.12) at un-conserved farmland with control farmland. This is due to biological soil conservation practice stabilized with Desho and Vetiver grass strips have a better effect in soil organic matter accumulation and this variation in SOM could be attributed due to the erosion reduction effects of biological SWC practice implemented in farmland and may hold great potential for increasing SOM levels. This finding agreed with [21] who assessed the effect of integrated SWC measures on key soil properties was higher soil organic matter (SOC) (3.69%) in conserved catchment as compared to non-conserved (2.24%). Higher mean SOM (2.79±0.24) was observed in the (<15%) slope than in the higher slope gradient 15-30% (2.38±0.20). The results indicate that soil organic matter is inversely related with slope gradient (Table 2). This may be due to the organic matter removal (transportation) from the upper slope to the lower one. This is in agreement with Yihenew, G. S., A. Fentanesh, and A. Solomon [36] had reported the dependence of SOM content on landscape position where the increasing soil water content and fertile soil deposition at lower slope favors higher crop biomass production and the result higher SOM content.

The soil organic matter rating of the study area is medium. This according to Tekalign, M. and I. Haque [29] reported organic matter 2.1 to 4.2 as medium rating.

Total nitrogen also showed a significant variation (P=0.0001) with respect to treatment. Total nitrogen was higher (0.23±0.18) in farmland conserved with Desho grass and lower in un-conserved control farmland (0.13±0.01) (Table 2). The overall total nitrogen content in soils under conserved farmland with Desho and Vetiver grass strips was significantly higher than un-conserved adjacent control farmland (Table 2). Similarly finding with Tigest, A. and F. Getachew and Worku, H., M. Awdenegest, and Y. Fantaw, [32, 35] reported that TN is higher in conserved land than non-conserved land.

Higher TN was observed in the lower slope (3-15%) than in the higher (>15- 30%) slope gradient. This might be due to the removal (transportation) of organic matter from the upper slopes and its deposition in to the lower slopes because of soil erosion since organic matter is the major source of TN and leaching to the down slope.

This is agreed with Abay, C., A. Abdu, and M. [1] who reported that, the variation in TN with in slope might be due to the removal of OM from the higher or steep slopes as a result of soil erosion and leaching to the down slope. Based on Tekalign, M. and I. Haque [29] ratings, TN in soil of the study area can be described as low to medium.

Table 2. *Soil chemical Properties of topsoil (0–20 cm depth); pH (1:2.5) %SOM %TN, AV.P (ppm), CEC (meq/Kg soil at Two slope Gradients under the Three Treatments (mean ±S.E.).*

Variable	Slope gradient	Conservation practice			overall
		Desho grass	Vetiver grass	control	
	3-15	5.98±0.22a	5.94±0.16a	5.13±0.23c	5.68±0.13a
pH (1:2.5)	15-30	5.45±0.16b	5.4±0.29bc	5.12±0.29c	5.32±0.15b
	Overall	5.72±0.13a	5.67±0.12a	5.12±0.16b	
	3-15	3.36±0.39a	3.10±0.31a	1.93±0.21c	2.79±0.24a
%SOM	15-30	2.74±0.23b	2.57±0.27b	1.84±0.17c	2.38±0.20b
	Overall	3.05±0.21a	2.83±0.21a	1.88±0.12c	
	3-15	0.26±0.0.03a	0.23±0.03b	0.13±0.02d	0.21±0.02a
%TN	15-30	0.21±0.02b	0.19±0.01bc	0.13±0.01d	0.17±0.03b
	Overall	0.23±0.18a	0.21±0.19b	0.13±0.01c	
	3-15	7.98±0.52a	7.81±0.43a	4.52±0.06c	6.14±0.06a
AV.P (ppm)	15-30	6.96±0.35b	6.71±0.31b	4.33±0.21c	5.71±0.52b
	Overall	7.02±0.29a	6.99±0.28a	3.77±0.18b	
	3-15	33.37±1.72a	31.35±0.62ab	22.79±0.95c	29.17±1.46a
CEC (meq/Kg soil	15-30	29.91±1.46b	29.60±0.99b	22.43±1.33c	27.31±1.65b
	Overall	31.80±0.47a	30.31±1.12b	22.61±0.74c	

Note:-Means within rows followed by different letters are significantly different (p < 0.05) with respect to treatment and slope gradient.

The overall average Av-P values were statistically significant with respect to treatments (P=0.001) and slope gradients (P=0.0001) (Table 2). The highest mean average value of soil Av-P (7.02±0.29) observed in conserved farmland with Desho grass strips and the lowest mean average of Av-P (3.77±0.18) at un-conserved control farmland.

The mean value of Av-P in soil under conserved farmlands (Desho and Vetiver grass strips) was relatively higher than adjacent control farmland. This could probably be due to higher organic matter content in the conserved plots than in the adjacent control land. This result agreed with the findings of Worku, H,[34] who stated that Av-P concentrations in farm plots with soil conservation structures were found to be significantly higher than in the adjacent non-conserved farm plots.

The overall Maximum mean value of available P value was 6.14±0.06 ppm found on lower position conserved with Desho and Vetiver grass SWCP and lower mean available P value was 5.71±0.52 ppm was measured on un-conserved control farmland. This might be due to the washing out of topsoil and organic matter from the higher slope gradients and their subsequent accumulation at the lower gradient/deposition zone. This agreed with the findings of Mulat, G., et al., [23] reported that, the removal of soil, organic carbon and basic cations from the upper slope and accumulation in the lower slope positions.

The overall average CEC values were statistically significant with respect to treatments (P=0.0039) and slope gradients (P=0.0001) (Table 2). The highest mean average value of soil CEC (32.80±0.47) observed in conserved farmland with Desho grass and the lowest mean average of CEC (22.61±0.74) at un-conserved control farmland. The highest recorded might be due to the presence of Desho and Vetiver grass strips conservation practice leads to decomposition and high soil organic matter and clay content are contributed for better soil CEC in farmlands conserved with SWC practices (Desho and Vetiver grass strips) and the lowest record may be due to the lower organic matter and exchangeable base content, and lower pH value of the adjacent control farmland. The result was in line with the study conducted by Fassil, K. and Y. Charles, y [10] who reported that the amount of clay and amount of organic matter present in the soil are responsible factors for increase in soil CEC.

The mean average CEC value was lower (27.31±1.65) in slope >15% and higher (27.17±1.46) in <15% slope. This finding implies that, the transportation effect that was caused by erosion from upslope and higher organic matter deposited at lower slope and amount of clay content, due to this effect there were a significant variation among the slope gradients. This is in line with [1] who reported that the highest (CEC) observed in lower slope and the lowest (CEC) value observed in higher slope gradient. Following Murphy B. and Hazelton P.[25] The rating of CEC, soils of the study area could be regarded as medium to high CEC ranges.

Interaction effects of conservation practice and slope gradients.

The interaction effects of the conservation practice and slope gradient (p =0.0363) were also significant for which the conserved gentle slope farmland has lower mean soil bulk density value relative to the un-conserved moderate slope farmland.

The conserved farmland has a lower mean bulk density value (1.02±0.05b) than the un-conserved farmland (1.16±0.05a) as indicated in (Table 1). This might be the decomposition of plant biomasses on the field increases organic matter content on the conserved land which in turn decreases the bulk of the soil. Lemma, T., T. Menfes, and Fantaw Yimer., [17] Also agreed that, the soil bulk density on gentle slope is lower than in the steep or higher slope gradients.

Soil organic matter (SOM) (significant difference between slope-treatment interaction effects at (P=0.0340) (Table 2). The conserved farmland has a higher mean SOM value (3.05±0.21a) than the un-conserved farmland (1.88±0.12c) as indicated in (Table 2).

In addition to this the highest values of SOM content could be because of high amount of rainfall that reduces the rate of organic materials decomposition in the study sites. Inline finding shows that, the use of Desho grass strip ensure sustainable land management practices [28] and vetiver grass had an ameliorative effect on soil quality, it not only increased the soil organic matter in the surface soil, but also improved the physical and biological properties which are important for crop production and the environment in general [20].

SOM was the most conspicuous soil property that was influenced by the presence of Vetiver grass in the farmland and this was also strongly correlated with a wide range of other soil properties.

The others selected soil chemical properties (pH, TN, Av-P and CEC) were affected by conservation practice and slope gradient and all these soil chemical properties were higher in the farmland treated with Desho and Vetiver grass strips at gentle slope. Similarly, different studies Abay, C. A. Abdu, and M. Tefera and Abdisa, G., et al [1, 2] reported soil and water conservation measures affect SOC and the SOC had strong correlation with the other soil properties.

4. Conclusion

The results of soil analyses done with the selected soil physical and chemical properties revealed that Desho and Vetiver grass strips SWC practices had shown an enhancement on these soil properties by reducing soil erosion and thereby contributing for the addition of organic matter. Farmlands treated with Desho and Vetiver grass strips in the study area for the last five consecutive years have improved, soil pH, soil organic matter, total nitrogen, available phosphorus, and cation exchange capacity through minimizing erosion and adding organic matter in the soil. The study showed that when the slope gradient increases significantly increases soil Bulk density and sand content while SOM, total N, available phosphorous and cation exchange capacity were decreased.

Generally, the soil physical and chemical properties were better in farmland conserved with Desho and Vetiver grass strips plots than the un-conserved adjacent control farmland and biological SWC practices (Desho and Vetiver grass strips) are promising impact to rehabilitate degraded lands, erosion control, sustainable watershed management and improve soil physical and chemical properties. Thus, this study recommends, to improve soil physical and chemical property, integrated physical structure and biological soil and water conservation practice could be added for better effect. Moreover, further research need to be conducted on the use of Desho and Vetiver grass strips on socio-economic aspects for a better understanding of the sustainable use of the land resource.

Acknowledgements

We would like to thank the farmers who allowed us to take soil sample and provided us with the necessary information.

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