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Assessment of Soil and Water Conservation Practices and its Implication on Soil Physicochemical Properties, at West Guji Zone, Gelana Woreda, Southern Ethiopia

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ABSTRACT

Background: Land degradation is one of the major challenges in developing nations like Ethiopia. The study was conducted on both conserved and non-conserved land. A total of 18 composite soil samples were collected from the top 0-20 cm soil depths to analyze the selected physical and chemical properties of soil.

Methods: For data analysis one-way analysis of variance (ANOVA) were used. From our observation soil and water conservation practice which is found in our study area was soil cut-off drains, waterways, bunds and bench terrace and also traditionally they use horizontal plough, land rotation, crop rotation and mulching soil management.

Result: The results revealed that soil chemical and physical properties: soil organic matter, available phosphorous, soil pH, cation exchange capacity, bulk density and soil moisture shows significant difference between conserved and non-conserved lands. However soil texture and total nitrogen shows no significant difference. The non-conserved land had low organic matter, Cation exchange capacity, total nitrogen, available phosphorous, soil moisture and with highest bulk density. Further research is recommended to study the magnitude of the effects and a better understanding of sustainable soil and water conservation practices.

Key words: Conserved land, Soil and water conservation practices, Soil physico-chemical properties, Un-conserved land.

INTRODUCTION

Background of the study

At the current time, the degradation of natural resources is among one problems facing humans throughout the world. International Soil Reference and Information Center (1995) estimated that nine million hectares of the world lands were extremely degraded and their original biotic functions were severely degraded. However, 1.2 billion hectares of the world land was moderately degraded. Worldwide inappropriate agricultural practices account for 28% of the degraded soils (Addisu, 2011).

Similarly, in Ethiopia the depletion of the soil resource is huge. Dominated by small-scale agricultural practices, Ethiopia is one of the most severely soil eroded countries in the world. Natural resources degradation is the main environmental problem in the country. Degradation mainly manifested through soil removal, nutrient exhaustion, deforestation and surface run off water. The majority of the farmers in rural areas of Ethiopia are subsistence-oriented, commonly cultivating impoverished soils of sloppy and marginal lands where soil removal were highly susceptible (Abebe, 2011; Lemma *et al.,* 2017).

The basis for the implementation of the soil and water conservation interventions on a large scale was since the 1975 land reform and the establishment of Peasant Associations (PAs). The reform gives farmland to farmers that motivated them and the PAs to facilitate the implementation of soil and water conservation and played an instrumental role for labor mobilization (Tolera, 2011; Tesfaye *et al.*, 2014).

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The aim of this study is to investigate effects of SWC practices on some key soil properties so as to draw conclusions that contribute in future improvement and implementation of SWC measures in improving soil for a better land productivity, erosion control and sustainable use of resources available in the study area.

Statements of the problem

The prevalence of traditional agricultural land use and inappropriate soil conservation practices in Ethiopia often resulted in the degradation of our natural resources. Land degradation, improper soil and water conservation practice and lack of adequate information on soil and land resources for their sound management practices could be among other major problems responsible for the existing low food crop production and poverty in the country (ILRI, 2003; CSA, 2003). The average annual rate of soil loss in the country is estimated to be 42 tons/hectare/year which results to 1 to 2% of crop loss (Habtemariam, 2013) and it is sever on steep slopes and on the places where vegetation cover is low.

In order to fill this gap it is useful in generation of basic information on soil and water conservation practice and its implication on soils physico- chemical, biological properties and site characteristics to assess the suitability of soils for crop production and productivity. It contributes to the recognition of the local problems of soils and water conservation and the interacting factors in use of soils for specific land utilization and crop types.

Basic research questions

- ❖ What are the existing soil and water conservation practices in Gelana woreda Woreda?
- ❖ What is the effect of the existing Soil and Water Conservation practice on selected physical and chemical properties of the soil in the study area?
- ❖ What is the selected physicochemical property of the soil in conserved and non-conserved land found in the study area?

Objectives of the study

General objective

The general objective of the study is to assess the soil and water conservation practices and its implication on the selected physicochemical properties.

Specific objectives

The specific objective of the study:

- ✓ To assess and identify the soil and water conservation practices in the study area.
- ✓ To evaluate the effect of soil and water conservation practices on selected physico-chemical properties of the soil.

MATERIALS AND METHODS

Description of the study area

The study area is located in Southern Ethiopia, Oromia National Regional State, West Guji Zone, Gelena Woreda. The Woreda is located at 449km from the regional capital city of Assossa and 557km eastern of Addis Ababa. Debatie woreda is lies between a latitude and longitude of 10°31′-10°39′N and 36°10′-36°13′E with an altitude between 1300 to 1750 meters above sea level.

Methods of data collection

To assess the SWC practices and its implication on selected soil physicochemical properties in the study area, both primary and secondary data were collected to justify the objectives.

Sample size and sampling technique

Soil sampling sites were selected based on land use type, altitudinal gradients of the landscape and vegetation types (tree, shrubs and herbs). At the beginning, a general visual field survey of the area was carried out to have a general view of the study area. Then, three Kebeles were selected purposively based on their status of soil and water conservation practices and for their longer age of conservation that was above six years old.

Sample size and its techniques

The total area of the study site was is around 70 hectare of which Dibati 20 hectare, Hangtok 25 hectare and Parzait 25 hectare. Soil sampling sites were selected based on altitudinal gradients of the landscape and vegetation types (tree, shrubs and herbs). Soil samples were taken from three kebeles they had relatively equal status soil and water conservation practices and soil samples were collected both from the land soil conservation practices were carried out and the nearby land without conservation practices.

Laboratory analysis

Composite soil samples were air-dried, grinded and sieved to pass through a 2 mm sieve to make it ready for lab analysis. The soil laboratory analysis was done at Pawi Agricultural soil research and fertility improvement center. Selected soil fertility indicators such as soil texture, soil moisture, soil pH, bulk density, total nitrogen, organic carbon, available phosphorus, exchangeable bases and caution exchange capacity were analyzed using standard laboratory procedures. For the analysis of total nitrogen and organic carbon content, the soil sample was further sieved by 0.5 mm sieve.

Statistical data analysis

The data obtained from the laboratory analysis were subjected to one-way analysis of variance (ANOVA) using the general linear model (GLM) procedure of the statistical analysis system (SAS) software version 9.1.3 (SAS, 2010) to compare statistical difference in soil variables between conserved and non-conserved areas. Moreover, least significant difference fisher's (LSD) test P at 0.05 was used to compare and separate for significant means.

RESULTS AND DISCUSSION

The existing soil and water conservation practices

The various soil and water conservation practices have been applied by community participation on their own farm plots and grazing lands in the study area. Soil and water conservation practice which was found in our study area was soil cut-off drains, waterways, bunds (soil /stone) stone fenced soil bund and bench terrace and also traditionally they use horizontal plough, land rotation, crop rotation, mulching and apply residuals (manure) for soil management.

The effect of soil and water conservation practices on soil physical properties

Soil texture

Soils of the conserved land had relatively the highest percent of clay and lowest percentage of sand compared to the soils of the non-conserved. The conserved land had shown relatively the highest mean of clay soil (41.3%) in comparison to the non-conserved land (40%). On the contrary, the lowest mean of sand content was observed in the conserved area (39.3%) which is the effect of conservation practices to accumulate better organic matter and clay materials as indicated under Table 1.

Soil bulk density

The soil bulk density of conserved land in our study area was significantly ($p<0.05$) affected by the soil and water conservation practices. Soil bulk density is the most popular measure to assess the degree of soil compaction (Worku *et al.,* 2012; Tegegne, 2014). It related with pore spaces which indicates aeration and water holding capacity of the soil. The conserved land has a lower mean bulk density value (0.85 g/cm^3) than the non-conserved land (1.34g/cm^3) as indicated in (Table 2). This is due to the presence of higher organic matter and pores nature of the soil as a result of conservation practices which is done in the area.

Soil moisture content

Soil moisture content (SMC) is reported as the ratio of the mass of water present in a soil sample to the mass of the sample after it has been dried at105 °C to a constant weight (Fikru, 2009; Kebede, 2015).The result of soil moisture content in our study area showed significant variation between conserved and non-conserved land with soil and water conservation structures. Higher SMC (6.04%) was observed from conserved land and the lowest (3.94%) was observed from non-conserved land.

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

Soil pH

In the study area soil pH shows significant variation ($p < 0.05$) between conserved and non-conserved land as explained under Table 3. This might be soil conservation practices applied on the land might minimize the loss of basic cations through leaching by flood and surface runoff through flash and water; this comfortable condition can increase relatively the pH of conserved soil as compared with the non-conserved soil.

The result is in agreement with different scholars who observed lower pH value from the non-conserved land as compared to conserved one (Getahun *et al.,* 2013) that was attributed to the high soil erosion, loss of basic nutrients, relatively lower base saturation percentage and lower soil organic matter content. And also in line with this Getahun *et al.* (2013a) reported that land with stone bund had higher soil pH (5.89±0.038) than control (5.81±0.043). Solomon *et al.* (2017) also recorded that soil pH in terraced cultivated land was higher (6.0) compared to non-terraced farm land (5.5).

Soil organic matter and total nitrogen

Soil organic Matter (SOM) as showed on Table 3, significant variation with respect to un-conserved and the conserved land. The lowest mean soil organic matter was occurred in non-conserved area (2.26%), while soil OM showed the highest (3.59%) in conserved area with soil bund as

Table 1: Soil texture class at the respective conserved and un-conserved plot of lands.

Site code	Soil texture			Texture class
	Clay (%)	Sand (%)	Silt (%)	
		Conserved		
Co-01	52	20	28	Clay
Co-02	32	52	16	Sand Clay
Co-03	40	46	14	Sandy clay
Mean	41.3	39.3	19.3	
		Non-conserved		
Un-01	46	38	16	Clay
Un-02	32	39	13	Sandy clay
Un-03	40	44	16	Sandy clay
Mean	39.3	40.3	15	

Co-stands for conserved land while Un-stands for non-conserved land.

Table 2: Soil bulk density and soil moisture content analysis result.

Land type	Variables (soil physical properties)	
	BD (g/cm^3)	SMC (%)
Conserved land	0.85^a	6.04^a
Non-conserved land	1.34^b	3.94^b
LSD(0.05)	7.91	8.14
CV (%)	0.20	3.55
Significance at(p<0.05)	**	**

Note: (**)- sign shows that there is a significance difference at 95% probability or with the consideration of 5% error, LSD= Least significant Difference, CV= Coefficient of Variation.

Table 3: Soil pH, soil organic matter and total nitrogen analysis result.

Land type	Variables (Soil chemical properties)		
	PH	SOM (%)	TN (%)
Conserved land	5.93^a	3.59^a	0.17^a
Non-conserved land	5.56^b	2.26^b	0.11^a
CV (%)	5.11	11.42	16.15
LSD (0.05)	0.29	1.27	0.06
Significance at (p<0.05)	**	**	Ns

Note: (**)- sign shows that there is a significance difference at 95% probability or with the consideration of 5% error, LSD = Least significant difference, CV= Coefficient of variation, (Ns) - shows that there is no significance difference at 95% probability.

Table 4: Soil, available phosphorus and cation exchange capacity analysis result.

Land type	Variables (Soil chemical properties)	
	Av.P (ppm)	CEC (meq/100g)
Conserved land	4.18[a]	32.79[a]
Non-conserved land	1.46[b]	20.82[b]
CV (%)	15.67	4.30
LSD (0.05)	0.72	1.15
Significance at (p<0.05)	**	**

Note: (**)- Sign shows that there is a significance difference at 95% probability or with the consideration. of 5% error, LSD= Least significant difference, CV= Coefficient of variation.

Gebresilase *et al*. (2009) also reported that the non-conserved fields had significantly lower SOM as compared to the conserved fields. This might be because of the decomposition of different plant biomasses on the soil of conserved land. According to Adisu (2011) the overall mean SOM value of the study site rangeds between (3.59 - 2.26); which is categorized under the rating of medium to low.

Available phosphorus

Available phosphorous in the studied area were found to be significantly different (p<0.05) between the conserved and non-conserved land. Results of the experiment indicated that the lowest percent of available phosphorus (1.46 ppm) was recorded in the non-conserved land lands while higher percentage of available phosphorous (4.18 ppm) was recorded in the conserved land as indicate on Table 4. This could probably be due to higher organic matter content in the conserved land than in the non-conserved ones this improved higher soil organic matter contents increased available phosphorus content and protect it from the removal and fixation of phosphorus. This result supported by Abreha (2013).

CONCLUSIONS

Soil and water conservation practices have been an important means to reverse the degraded land and limit further damages to the land resources. They have been a tool for the communities to care for their local environment. SOM, available phosphorus, pH CEC and SMC showed significantly higher mean values in conserved land as compared to non-conserved land. Furthermore, the mean values of soil pH, total nitrogen and clay content, were better following conserved lands than non-conserved lands, even if the difference was not statistically significant. Therefore the result of the study indicated that most of the parameters show significant difference among the conserved and un-conserved land. This indicates the positive impacts of soil and water conservation practices in improving the nutrient status which, in turn plays a great role in benefiting the local households and farmers, the local community and the society at large. However the soil fertility status in the conserved land in the study area was still very low.

Recommendations

Based on the result of this study, the following recommendations were made:

- All stakeholders encourage farmers and the community at large in the facilitation, adoption and implementation of SWC measures in different land use system.
- For future direction, detail research on SWC practices should be done to get a comprehensive and informative results on effects of each SWC measures on physical and chemical properties of soil, socio-economic development, environmental impacts, cropping and tillage systems, *etc*. and also analyzing the cost effectiveness of recommended SWC techniques on soil fertility paramount important.
- Finally, all stakeholders especially farmers should be encouraged to incorporate all SWC technologies as much as possible to increase production and productive of the soil.

Conflict of interest: None.

REFERENCES

Abebe, S. Hans, H. Getez, Z. and Berhanu, D. (2011). Indigenous Knowlage in L and Management for Sequestration and Soil Based Ecological Services in DamotSore (Wolayta), Southern Ethiopia, A Report Submitted to International Sart Secretariat.

Assefa, F. (2009). Assessment of Adopted Behavior of Soil and Water Conservation Practices in the Lake Koga Watershed Highlands of Ethiopia. MA Thesis, Cornell University.

Assefa, H. (2013). An Assessment of Indigenous Knowledge and Practices for Soil Conservation and Improving Soil Fertility: A Case of Jima Rare of East Wollega, Addis Ababa University, Ethiopia.

CSA (2003). Statistical Report on Area and Production. Results for Amhara Region, Part II Addis Ababa, Ethiopia.

Damtew, A. (2011). Benefit and Challenge of Adoption Soil Conservation Techniques in Goromt Watershed Central Ethiopia, Addis Ababa University, Ethiopia.

Gebreselassie, Y. Amdemariam, T., Haile, M. and Yamoah, C. (2009). Lessons from upstream soil conservationmeasures to mitigate soil erosion and its impact on upstream and downstream users of the Nile River". International Water Management Institute. Pp: 170-183.

IIRR (2003). Recording and Using Indigenous Knowledge: A manual, International Institute for Rural Reconstruction (IIRR),Silang, Cavite, Philippines, pp: 211.

Kebede, W. (2015). Evaluating Watershed Management Activities of Campaign Work in Southern Nations, Nationalities and Peoples' Regional State of Ethiopia. Environ Syst Res 4:6. Kimmins, J.P., 1997. Forest Ecology: A Foundation for Sustainable Management, 2nd Ed., New.

Kidanemariam, A. (2013). Soil acidity characterization and effects of liming and chemical fertilization on dry matter yield and nutrient uptake of wheat (*Triticum Aestivum* L.) on soils of Tsegede District, Northern Ethiopia. PhD Dissertation, Harames University, Haramaya, Ethiopia.

Kitila, G., Gebrekidan, H., Tena, Alamirew, Megersa, Olumana, Hans, H. (2013a). Landuse changes induced by irrigation development in the Fincha'a Valley Sugar Estate, Nile Basin, Ethiopia. Journal of Biodiversity and Environmental Sciences. 3(11): 31-47.

Lemma. T., Menfes, T., Fantaw, Y. (2017). Effects of integrating different soil and water conservation measures into hillside area closure on selected soil properties in Hawassa Zuria District, Ethiopia. J Soil Sci Environ Manag. 6(10): 268-274.

Tatek, T. (2014). Perception of Farmers on Soil Erosion and Conservation Practices in Dejen District, Ethiopia. International Journal of Environmental Protection and Policy. 2 pp. 224-229. doi: 10.11648/j.ijepp.20140206.15.

Tesfaye, A., Negatu, W., Brouwer, R. and Van Der Zaag, P., (2014). Understanding soil conservation decision of farmers in the Gedeb watershed, Ethiopia, Land Degrad. Dev. 25: 71-79.

Tolera, M. (2011). Assessing the Role of Traditional Land Management Practices in Improving Crop Land Productivity: The Case of Diga Woreda, Oromia.

Worku, H., Awdenegest, M. and Fantaw, Y. (2012). The Effects of 'Fanya juu' Soil Conservation Structure on Selected Soil Physical and Chemical Properties: The Case of Goromti Watershed, Western Ethiopia. Resources and Environment.