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Pre-Extension Demonstration of Integration of Both Mechanical and Biological Soil and Water Conservation Practices in Kofele District, West Arsi Zone, Oromia

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Abstract

Soil erosion is one of the major challenges of Ethiopia deteriorating the productivity of land. Soil and water conservation (SWC) is the only practice to reverse the threat and protect the land. Over the last three decades, different soil and water conservation activities have been undertaken. However, soil erosion still persists and become major threats of Ethiopian farmers. Despite the massive mobilization of resources for SWC, only very few farmers have been practicing integrated soil and water conservation measures for restoration of degraded agricultural land. In addition, there is lack of information among farmers on the impact of SWC on soil fertility improvement and soil nutrient content dynamics. This study was conducted in Kofele district, which is one of AGP district, in West Arsi Zones of Oromia. The study was aimed to demonstrate the impact of integrated Soil and water conservation measures in restoring degraded agricultural land. Dasho and Elephant grasses were planted on graded soil bund as an integration measures at four farmers field. Farmer's field visit was arranged two times in two years to share practical experiences among the farmers and DA. It was also identified that soil nutrient contents in terms of total nitrogen, available phosphorous, available potassium and soil organic carbon content showed an increasing trend since establishment (2016). On the other hand, this kind of soil and water conservation practices on agricultural land showed promising way of carbon sequestration as the climate change mitigation strategy. The study recommended the use of integrated soil and water conservation measures as strategy of rehabilitating degraded agricultural land as apart of integrated water shed management.

Keywords: Soil and water conservation; Soil erosion; Soil nutrient.

1. Introduction

Agriculture is the major source of livelihood in Ethiopia. However, land degradation in the form of soil erosion has hampered agricultural productivity and economic growth of the nation [1, 2]. Land degradation, low agricultural productivity and poverty are critical and closely related problems in the Ethiopian highlands [3]. Investments in soil and water conservation (SWC) practices enhance crop production, food security and household income [4]. Recognizing these connections, the government of Ethiopia is promoting SWC technologies for improving agricultural productivity, household food security and rural livelihoods. Particularly in the Ethiopian highlands, different SWC technologies have been promoted among farmers to control soil erosion problem. The traditional physical SWC measures, such as soil bund and terraces, have been practiced in a few areas for several hundred years for which awareness and experience have been confined in that particular area. The structures having certain technical designs and specifications have been introduced to many new areas, assuming that land users can adopt it sooner or later. Recently, pilot projects, campaign work, food for work programs (grain and edible oil support), etc. were initiated and are ongoing by both government and non-governmental organizations. However, most of these SWC technologies, especially construction of SWC practices on agricultural land, has got less acceptance in different parts of the country [5, 6], largely because investments by farmers in SWC are influenced by the ecological, economic and social impacts of the SWC technologies. The actual and long term financial profitability to farm households critically influences the process of accepting and replicating such structures [7]. Poverty and a long time span to get return from soil conservation activities reduced adoption of SWC technologies in East Shewa (Ethiopia. In the northwestern Ethiopian highlands, labour shortage, problems with fitness of the SWC technologies to the requirements of farmers and land tenure insecurity discouraged farmers from adopting SWC measures such as soil and stone bunds, fanya juu, etc. [8].

Therefore, it is important to improve farmers' level of understanding on the effect of soil and water conservation technologies in controlling soil erosion and maintaining soil nutrient content on agricultural land. On the other hand, participatory evaluations of these technologies are also equally crucial to improve farmers' level of adoption of SWC technologies. Despite the massive mobilization of resources for SWC, only very few farmers have been practicing integrated soil and water conservation measures for restoration of degraded agricultural lands. In addition, there is lack of information on the impact of SWC on soil fertility improvement and soil nutrient content dynamics.

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2. Objectives

2.1. Demonstrate and improve farmers' practical level of awareness/understanding on SWC technologies.

2.2. To evaluate impact of integrated soil and water conservation on soil nutrient change.

3. Expected Output

3.1. Farmers underestanding on the integration of both physical and biological SWC improved

3.2. The contribution of the integrated SWC in storing SOC and other major crop nutrient on agricultural land known

4. Materials and Methods

The soil and water conservation measures were established at four different Sites/farmers in Kofele district on an area of 30mx50m at each farmer. A total of Four FRG (one FRG under each farmer) was established. Animal forages such as Elephant and Dansho grass were used as an integration measure with soil bund. Farmers' field visit was done to improve farmers' level of understanding on SWC technologies. Composite Soil samples were collected from each site every year since establishment and analyzed to evaluate soil nutrient dynamics.

5. Result and Discussions

5.1. Farmers Training and Field Visit

Farmers training and field visit were arranged for all FRG members, DA and Experts of the district to create awareness on the contribution of integrated SWC practices in controlling soil erosion, improving soil fertility and as additional source of feed for livestock. A total of 40 farmers grouped in four FRG, 9DA, and 9 Experts participated in field visit and training from 2016-2017 (Table 1).

Table-1. Training and field visit participants from 2016-2017

Years	**Name of site/Farmer**	**No. of FRG**	**No. farmers organized as FRG**			**DA**			**Experts**			**Total**
			M	**F**	**Total**	**M**	**F**	**Total**	**M**	**F**	**Total**	
2016	Ula Bara/Haji	1	7	3	10	4	1	**5**	3	2	**5**	10
	Afamo/Mohamed	1	8	2	10							
	Garmama/Gulilat	1	7	3	10							
	Alkaso/Qasim	1	8	2	10							
2017	Ula Bara/Haji	1	6	4	10	3	1	**4**	3	1	**4**	8
	Afamo/Mohamed	1	9	1	10							
	Garmama/Gulilat	1	7	3	10							
	Alkaso/Qasim	1	8	2	10							
Ground total		4	60	20	80	7	2	9	6	3	9	18

Figure-1. While conducting farmers field visit (June, 2017)

5.2. Farmers, DA and Experts' Perception

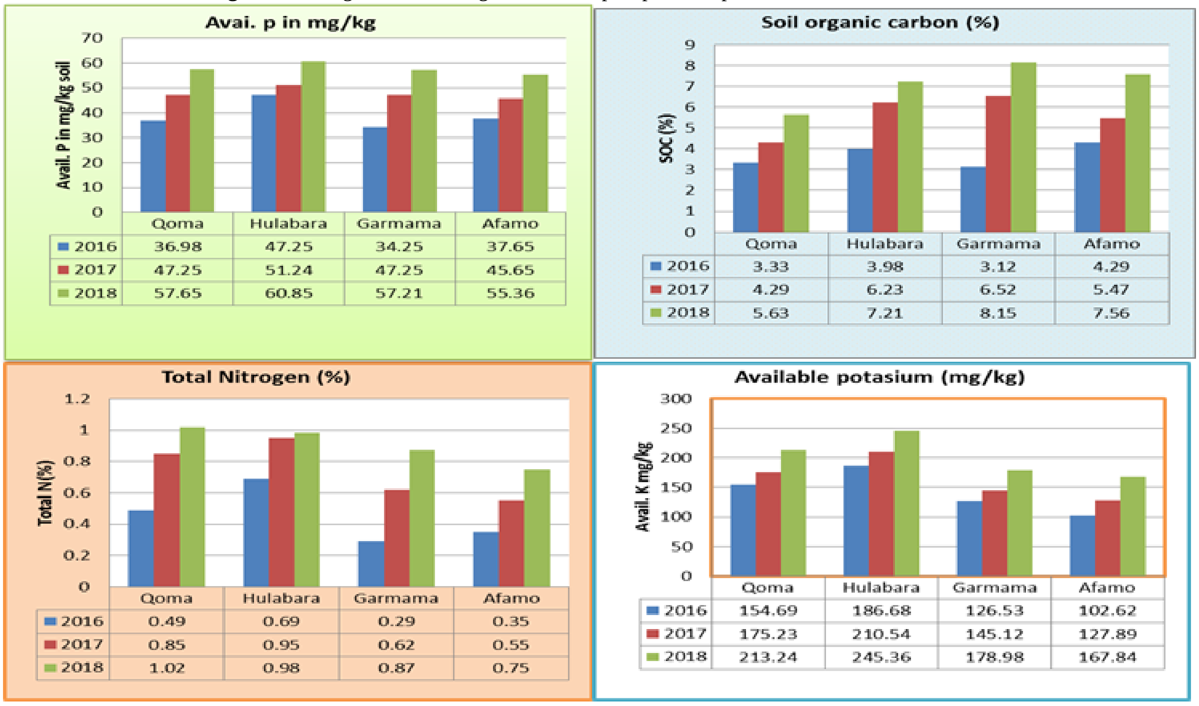
Farmers' perception on integrated soil and water conservation was assessed using prepared check list. Accordingly, 100% of the participants understand that integrated soil and water conservation is highly valuable in terms of controlling soil erosion, improving soil fertility and increasing land productivity. Development agents (DA) and experts, who are participated on this field visit, were also asked to say on their perception on the technology demonstrated. They have suggested that most of soil and water conservation practices conducted through campaign were not successful particularly on agricultural land due to farmers' lack of awareness on the contribution of soil and water conservation measures. In addition, even though different physical conservation structures are constructed every year, farmers are not interested to integrate the structures with the biological ones as they perceive that trees or grasses may reduce the land size and can compute for nutrient.

Therefore, to change farmers' negative perception on integrated soil and water conservation, such demonstration activities are very important. They have also planned to maintain such conservation structures and grasses for farther demonstration and scaling up it to different PA in the district.

5.3. Change in Soil Nutrient

Change in total Nitrogen, available phosphorous, potassium and SOC from 2016-2018 were assessed every year. Accordingly, Total N, available phosphorous, potassium and soil organic carbon showed an increasing trend at all sites since 2016 (Figure 2).

Figure-2. Change in total Nitrogen, available phosphorous, potassium and SOC from 2016-2018



Soil nutrient content is highly significantly different at $p<0.05$ between and within experimental sites across the years (Table 2). Major soil nutrient contents also showed an increasing trend since 2016 (baseline) indicating that integrated SWC measures interventions have appositive effect on improving soil nutrient content. On the other hand, SOC content of the soil showed an increasing trend since establishment of integrated SWC indicating that it is a promising way of carbon sequestration on agricultural land. In addition, Soil nutrient status in 2016 (baseline) is also smaller and highly significantly different from the soil nutrient status after intervention. EC (electrical conductivity) and soil pH are not significantly different ($p>0.05$) across the year and sites.

Table-2. Mean comparison of soil nutrient content at different site across the years

District	Years	Sites	Total N (%)	Avail. P in ppm	Avail. K in mg/kgsoil	EC in mmhos/cm	Soil pH	SOC (%)	C/N
Kofele	2016	Hulabara	0.63[de]	44.95[cde]	172.05[cd]	0.35[a]	5.19[ab]	8.19[c]	13.00[ed]
		Afamo	0.51[ef]	40.62[def]	148.00[d]	0.22[b]	4.99[b]	6.53[cd]	12.80[cde]
		Qoma	0.44[f]	34.73[f]	138.38[d]	0.21[b]	5.10[ab]	5.83[d]	13.25[cde]
		Garmama	0.42[f]	38.20[ef]	142.29[d]	0.27[ab]	5.35[ab]	6.45[cd]	15.35[abcde]
	2017	Hulabara	0.90[ab]	51.77[bc]	198.82[bc]	0.36[a]	5.11[ab]	10.67[b]	11.85[e]
		Afamo	0.67[cde]	47.37[cd]	155.16[d]	0.20[b]	5.7[ab]	9.89[b]	14.76[abcd]
		Qoma	0.84[abc]	47.90[cd]	170.94[cd]	0.24[ab]	5.79[ab]	13.23[d]	15.75[abcd]
		Garmama	0.69[cd]	49.28[c]	167.98[cd]	0.26[ab]	5.57[ab]	8.31[c]	12.04[cde]
	2018	Hulabara	0.76[bcd]	64.15[a]	254.86[a]	0.28[ab]	5.33[ab]	12.70[ab]	16.71[abc]
		Afamo	0.77[abcd]	62.62[a]	170.94[cd]	0.27[ab]	5.84[a]	11.69[ab]	15.18[abcd]
		Qoma	0.94[a]	59.18[ab]	229.55[ab]	0.26[ab]	5.80[ab]	10.08[b]	10.72[e]
		Garmama	0.83[abc]	57.60[ab]	198.24[bc]	0.27[ab]	5.57[ab]	9.94[abc]	11.97[e]
	CV (%)		14.61	9.87	12.19	26.73	8.97	13.07	15.06
	$LSD_{0.05}$		0.17	8.30	36.75	0.12	0.82	2.30	3.83
	p-value		0.00	0.00	0.02	0.25	0.34	0.00	0.01

Similarly, Eshatu [9] reported that SWC practices significantly increased organic carbon, total nitrogen and soil-organic matter in the soil. Other studies also indicated that there is a positive contribution of SWC measures to the reduction of soil erosion, conservation of soil moisture, and soil nutrient content [10-13]. Many other cases studies also indicated that integration of biological with physical measures improved effectiveness of the structure and soil fertility Zougmore, *et al.* [14] and Adimassu, *et al.* [15].

6. Conclusion and Recommendations

Major soil nutrients such as total nitrogen, phosphorous, potassium and SOC contents showed an increasing trend since establishments of integrated soil and water conservation measures at all sites. In addition to providing forage to the livestock and controlling soil erosion, integrated soil and water conservation can improve soil fertility and increase soil organic carbon pool. Based on this study, the following recommendations were given:

- ✓ Integrated SWC activities should be scaled up particularly on agricultural land as means to control soil erosion problem, improving soil fertility and as a source of feed for livestock
- ✓ Integrated soil and water conservation is a promising way of carbon sequestration on agricultural land. Therefore, this should be considered in the implementation of climate smart agriculture as strategy to mitigate climate change.

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