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Assessment and Documentation of Indigenous and Introduced Soil and Water Conservation Practices in the Case of Silte and Gurage Zone, SNNPR, Ethiopia

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Keywords: *FGD, indigenous SWC, introduced SWC, soil and water conservation, soil erosion.*

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Abstract- Soil erosion is the most limiting environmental factor for crop production in Ethiopia, particularly Southern Regional State. To reverse the land degradation problem, many indigenous and introduced soil and water conservation interventions were implemented in different parts of Ethiopia. However, this practice is not well documented and known in South-central zones. The current study has been initiated to assess the indigenous and introduced soil and water conservation practices in the Gurage and Silte zone. As a method; Key informant interview, Focused group discussion, observation through transect walk was used as a source of data. Key informant interviews has been conducted at zonal and woreda level to group two representative woredas per zone and three representative kebeles per woreda. Based on the key informant interviews, Sankura and Alicho-wuriro woreda from the Silte zone, whereas Meskan and Gummer woreda from the Gurage zone was selected based on their adoption potential of both indigenous and introduced soil and water conservation practices. From each selected woreda, three representative kebeles from highland, middle land, and low land were selected. Focus group discussion has been conducted with the involvement of women, Youth and Elders who have long experience in the area about soil and water conservation practices at selected kebeles. Several introduced and indigenous soil and water conservation practices has been identified. However, lack of ignorance by farmers to periodically maintain the structures aggravating soil erosion in their field. Unlike indigenous conservation structures, construction and design of each introduced conservation structures has not been based on technical standards of the Ethiopian Ministry of Agriculture (MoA). It has been recommended that the identified indigenous and introduced conservation measures which have a better role in reducing soil erosion in cropland should be scaled. The implemented conservation measures in different parts are different in their dimensions during field measurement, and their variation should be scientifically proven. Finally, in most parts, the constructed engineering measures should be periodically maintained and integrated with biological conservation measures.

Keywords: FGD, indigenous SWC, introduced SWC, soil and water conservation, soil erosion.

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I. Background and Justification

Soil erosion is a serious global environmental problem and constrains food production for the increasing world population (Lieskovský, 2014). Erosion is a major Environmental problem to the national economy of Ethiopia due to cultivation on steep slopes, clearing of vegetation, and overgrazing (Tamene, 2005). Many studies reported the extent of soil erosion based on erosion modeling. Soil Conservation Research Project (SCRP) estimated that about 1.5 billion tons of soil (Hurni, 1984; Kruger, 1995), whereas FAO (1984) and Hurni (1993) reported annual soil loss from Ethiopian highlands to be 200-300 tons ha-1yr-1. The impact of erosion is particularly severe in the highlands of the country (areas that lie above 1500 m), which constitute less than half of the country (≈ 43 percent of the country) (FAO, 1986). In the mid of 1980s, 50% of the highlands are significantly eroded, 25% seriously eroded, while 4% had reached a point of no economic return (FAO, 1986). The report of Bagegnehu et al. (2019) in the Southern Region reported the soil loss as 42,413.7 ton per year soil with an average annual soil loss rate of 4.27ton/ha/yr. The impact of soil erosion both on-site nutrient loss and off-site sedimentation of water resources ((Emrah et al. (2007)). The root causes of soil erosion in Ethiopia are due to deforestation, intense rainfall cultivation of steep slope to fulfill the demand of a growing population (Bewket, 2007; Adimassu, 2012).

In Ethiopia, soil and water conservation practices has been started after famine in 1973 and 1985 as food-for-work program to mitigate soil erosion problems (Hoben, 1996). After this program, various physical and biological soil and water conservation measures has been implemented by extensions, research institutions, and other development practioners through collective action community collective action, and farmer's personal trial (Wagayehu and Lars, 2003).

Indigenous soil and water conservation practices by farmers play a major role in facilitating the optimum level of production from a given area of land while keeping soil loss below a critical value. According

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to IFAD (1992), conservation measures are broad classified as agronomic measures, physical /structural/ measures, and biological/vegetative/ measures. According to Genene M. and Abiy G. (2014), most of the farmers in south western Ethiopia practices introduced and indigenous soil and water conservation activities like; contour farming, furrow making, residue leaving, agronomic practices, putting trash lines on contour, etc. However, the soil and water conservation practices are site specific and, particularly the contribution of indigenous conservation measures has been ignored by Extensions, farmers and research organizations. Therefore, the current study has been initiated to identify indigenously and introduced SWC practices, to measure and describe identified indigenous and introduced soil and water conservation practices, and to know socio-economic aspects of identified indigenous and introduced SWC Practices

II. Materials And Methods

a) Study area description

This study has been conducted in Silte and Gurage zone, Southern Nation Nationalities and Peoples Region (SNNPRs). Silte zone is bordered on the south by Halaba zone, on the west by Hadiya, on the north by Gurage zone, and on the east by East shewa. Geographically it lies between 38°3'25.812"E 7°45'10.864"N. Whereas, Gurage zone is bordered on the south by Silte zone, on the west by Jimma , on the north by Southwest shewa, and on the east by East shewa. Geographically it lies between 37°48'12.533"E 8°4'3.093"N. The major crops grown in both zones are maize, wheat, barley, teff, sorghum, beans, pea, potato, Enset(CSA, 2010)

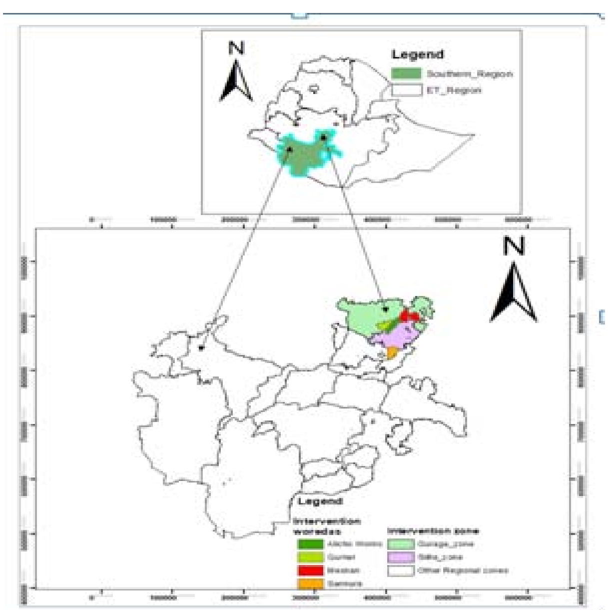

Figure 1: Location of the study area

b) Methods of data collection

As a data collection, key informant interview, Focus group discussion, field observation through transect walk has been used to generate the required data.

i. *Focus group discussion*

A discussion with Key informant has been conducted at zone and woreda level. Teams like a natural resource, irrigation, animal science, and plant science experts were participated to have information's about all woredas of the zone so that, the grouping of woredas was done based on its agro-ecologies and expectation to have indigenous and introduced soil and water conservation practices. Focus Group Discussion (FGD) with different social groups at the kebele level has been undertaken. The composition of social groups includes Youths, Women, and Elders know about SWC practices in the area (figure 1). A quick checklist has been prepared to collect the required information. The farmer's response has been validated with the information collected through a transect walk.

Figure 2: Focus group discussion

ii. *Field survey and Observation*

From the baseline information at zonal, woreda and kebele level, field observation on existing ISWC practices has been done with appropriate transect walk. The response of FGD has been validated through field surveys. The different SWC practices has been observed and measured to characterize identified indigenous and introduce SWC practices.

iii. *Key informant interview*

Key informant interviews were done at zone and woreda. This method of data collection in our current research is the primary step to identify the potential woredas and kebeles who have the best experience on indigenous and introduced soil and water conservation practices. During the interview, administrators, experts, and older farmers participated. At the kebele level, farmers who have long experience on indigenous and introduced soil and water conservation practices has been selected, and the required data has been collected.

c) Data Analysis and Presentation

Simple descriptive statistics like tables and figures were used as a means of data analysis. The analysis focused on a zonal basis to summarize the identified indigenous and introduced soil and water conservation practices.

III. Results and Discussions

a) Demographic characteristics of respondents

Focus group discussion has been conducted at each zone by selecting 44 respondents from each zone.

The following two tables describe the respondent demographic characteristics in teach zone.

Table 1: Demographic characteristics of respondents in Silte zone

Variables	Descriptive	Frequency	Percentage
Sex	Male	41	93.2
	Female	3	6.8
Age	18-30	4	9.1
	31-50	30	68.2
	51-70	8	18.2
	>71 years	2	4.5
Education	Read only	9	20.5
	Read and write	29	65.9
	1-8th	1	23
	9-10th	0	0
	Non educated	5	11.4
Marital status	Single	2	4.5
	Married	42	95.5
	Divorced	0	0
	Widowed	0	0
Religion	Orthodox	2	4.5
	Muslim	42	95.5
	Protestant	0	0
	Catholic	0	0

Table 2: Demographic characteristics of respondents in Gurage zone

Variables	Descriptive	Frequency	Percentage
Sex	Male	36	81.8
	Female	8	18.2
Age	18-30	8	18.2
	31-50	30	68.2
	51-70	6	13.6
	>71 years	0	0.0
Education	Read only	8	18.2
	Read and write	24	54.5
	1-8th	4	9.1
	9-10th	2	4.5
	Non educated	4	9.1
	Single	2	4.5
Marital status	Married	40	90.9
	Divorced	1	2.3
	Widowed	3	6.8
	Orthodox	12	27.3
Religion	Muslim	29	65.9
	Protestant	3	6.8
	Catholic		0.0

b) Existing soil and water conservation(SWC) practices

i. *Indigenous soil and water conservation(ISWC) practices*

Land degradation is a serious problem in central Ethiopia. To curve those threats, farmers apply various indigenous soil and water conservation practices. The structure varies from farmers to farmers across both locations. The identified measures has been discussed below

a. *Gurage and Silte zone*

Table 3: List of Indigenous Soil and water conservation practices in Gurage and Silte zone

SWC practices	Locations	Average dimension		
		L(m)	W(m)	D(m)
Ditcher	SZ	As interest	0.6	1.2
Contour farming	SGZ	-	0.2	0.15
Furrow making	SGZ	-	0.25	0.17
Planting pit	SZ	-	0.7	0.6
Planting cabbage across the slope	SZ	-	0.2	0.15
Planting Enset across the slope	SZ	-	2	*
Mulching for vegetables	SZ	-	*	*
Intercropping	SGZ	-	*	*
Strip cropping	SGZ	*	*	*
Trash line	GZ	10	0.4	*
Desho grass strip planted on soil bund	GZ	25	0.5	0.5

NB: SZ= Silte Zone; GZ=Gurage Zone, SGZ=Silte and Gurage Zone

- *Description of Indigenous Soil and water conservation practices*

Ditcher: is the traditional practices constructed around farmland with a dimension of 60cm top width and 1.2m height. Its length depends on the size of the farmland. Farmers use this structure for fence and prevent farmland from run-off.

Figure 3: Dicher at Silte zone

Planting pit: It is a form of water harvesting prepared with manure and constructed around homestead area majorly for soil fertility improvement for chat practiced by Alicho wuriro woreda farmers. During rainstorms, the pits catch runoff and concentrate it around the growing plant. Manure has been placed in the pits before planting a chat to improve soil fertility. Chat is planted thereby benefit from the increased moisture availability in the pits. The dimensions of are 70cm diameter, 60cm depth, and spaced 50cm. As compared to the standard 10-30 cm diameter, and 5-15cm depth by FAO (2003), the current measured dimensions are by far higher. According to Itabari and Wamuongo (2003), organic manure preferable from cattle and other forms is added and mixed with the soil to improve fertility, structure, and conserve moisture in the pit.

Figure 4: Planting pit at Silte zone

Contour farming: It is the activities of plowing and planting along the contour, and farmers majorly adopt this to prevent surface runoff and infiltration of water into the soil. Structures and plants has been established along the contour lines following the configuration on the ground. They were planting cabbage and Enset across the slope, which is the identified practice in silte zone.

Mulching is a management practice that combats the problem of water scarcity. Farmers around the silte zone use wheat stalk as a mulching material for vegetables, particularly for carrot seedling performance at nursery level as shown in (figure 5). The role of mulching was to improve soil moisture by reducing soil evaporation and gully side stabilization.

Figure 5: Mulching for Carrot

- *Living crop residue*

The practice of leaving crop residue after crop harvest for soil fertility and soil moisture improvement were well known in the selected areas of the central zone. The experience of barley and wheat straw in the field is another indigenous conservation practices identified from silte area (figure 6). The straw on their farmland has been used to improve soil fertility, conserve soil moisture, and reduce raindrop erosion.

Figure 6: Crop residue after harvest

Intercropping: Intercropping annual with perennial crops is one of the practices known in the Silte and Gurage zone. It is the practices of growing more than one crop in a piece of land. To increase the land productivity, farmers at silte zone intercrop Chat with potato, Enset with cabbage as a practice majorly to increase land productivity by improving soil fertility. Chat and cabbage is the most important cash crop in the area. Chat planted at 1m space, and potato has been planted in rows of chat at 50cm spacing (figure 7)

Figure 7: A combination of intercropping

Strip cropping: Practicing a strip of cereal with root crops is another conservation practice identified. Farmers practice strip majorly to efficiently utilize their land use. The component of strip cropping practiced in the area is *(wheat)-potato-chat-Enset plantation.*

- *Furrow making*

Farmers have experience in making furrow by creating 17cm soil depth and 25cm width along the contour for cereals and horticultural crop (cabbages) majorly to improve soil moisture and prevent soil erosion. The length of the furrow depends on the size of the farm (figure 8)

Figure 8: Furrow making experiences from Silte zone

ii. *Introduced soil and water conservation(ISWCP) practices*

a. *Gurage and Silte zone*

Table 4: List of Introduced Soil and water conservation practices in Gurage and Silte zone

SWC practices	Locations	Average dimension		
		L(m)	Width(m)	D(m)
Graded cutoff drain	SGZ	As interest	.3	.2
Fanya juu	SZ	As interest	2	.3
Soil bund	GZ	100	.5	.5
Cutoff drain	SGZ	15	.6	.4
Trench	SGZ	5	.5	.5
Planting sisal on graded soil bund	GZ	20	.4	.5
Wood Check dam	SGZ	15	1	.4
Stone bund	GZ	15	.3	.4
Soil bund	SZ	20	.5	.5
Fanya juu	GZ	8	.4	.4
Stone faced soil bund	GZ	80	1	.8
Farm fond	SZ	8	4	.5

NB: SZ= Silte Zone; GZ=Gurage Zone, SGZ=Silte and Gurage Zone

- *Description of introduced soil and water conservation measures*

Soil bund: Soil bunds are ridges and ditches made of soil, dug across the slope, or along the contour with a water retention basin at its upper part. Farmers construct soil bund in their farmland to reduce or stop the velocity of overland flow and consequently, soil erosion. The design of this structure varies from zone to zone. The sample of soil bund has been measured at the slope below 15%. Farmers in the Gurage construct soil bund with the an average length of 100m, 0.3 m the average bottom width, and the average depth of 0.5m and 20cm an embankment height (figure 8). However, farmers around the Silte zone design soil bund with an average length of 20m, 0.5m an average bottom width, 0.5 m depth and an embankment height of .35m. According to MOA (2016), embankment height of 50-75cm high and a bottom width of 100-150cm are appropriate dimensions for level soil bund. The design of each parameter across locations is by far below the standard. The variability of slope length in both locations has been related to the farm size.

Farmers construct soil bund in steeper and moderately steeper slope in their farm land. The practice is made from the soil and designed following the contour line and formed by digging the soil and thrown the soil down ward to form the embankment. Farmers construct it primarily for reducing the runoff generated from farm land which interns to increase crop productivity.

Figure 9: Soil bund at Gurage zone

Fanya juu terraces

Fanya juu is an embankment along the contour, made of soil, with a water retention basin at its lower part. Farmers construct soil bund in their farm land to retard the runoff or stop the velocity of overland flow by collecting it in the ditch. Farmers in Gurage zone construct fanya juu with an average length of 8m, 0.4m average bottom width, and average depth of 0.4m and 15cm embankment height. However, farmers around Silte zone design fanya juu of slope length based on their interest, 2m average bottom width, 0.3m depth and embankment height of 0.15. According to MOA (2016), embankment height of 50-75cm, a bottom width of 100-150cm and the ditch is about 0.5m deep is appropriate dimensions for level fanya juu. The design of each parameter across locations is by far below the standard. The variability of slope length in both locations has been related with the farm size. Farmers who have large farm size use large size.

Trench- is a short ditch dug along the contour to trap runoff water in dry and moist areas to plant trees out of farmlands. This structure is the well-known practice in both Silte and Gurage zones. Farmers construct the structures primarily to plant trees in the center of the trench to rehabilitate the degraded land. Farmers design them with an average length of 5m, 0.5m width and 0.5m depth (figure 10). As compared to the technical standard given by MOA (2016), a trench is normally 2-3m long and 0.3-0.5 m deep; depending on soil depth, the current dimension, particularly its length is long, and the depth is within the range of MOA technical guideline. In the center of the trench, no tree has been planted across the locations.

Figure 10: Overview of trench at Gurage zone

Planting sisal on graded soil bund

Graded soil bund is similar with level bund, with the only difference being slightly graded sideways, with a gradient of up to 1%, towards a waterway or rivers. Farmers in the Gurage zone integrate Sisal as biological conservation measures with graded soil bund majorly to control dispersed runoff by retarding its velocity on farmlands and gullies, which ultimately mitigate land degradation (figure 11)

Figure 11: Overview of Sisal planted on graded soil bund at Gurage zone

Stone bund- farmers have the experience in preventing soil erosion from their farmland by constructing Engineering soil and water conservation measures. Due to the availability of a stone in the area, farmers align stone along the contour to build stone bund. During design, certain depths has been constructed, and stone is aligned straight to form the embankment height of 0.50cm (figure 12)

Figure 12: Overview of stone bund in Gurage zone

The Farm pond is a rectangular structure constructed with the dimension of side length 3.5m and width of 8m with the primary focus of rainwater harvesting for sustainable crop production to reduce the risk of crop failure during the dry spell. The plastic-lined is used to prevent seepage loss (figure 13)

Figure 13: Farm pond at Silte zone

IV. Conclussion and Recommendation

Several introduced and indigenous soil and water conservation practices were identified. Although lack of ignorance by farmers to periodically maintain the structures aggravating soil erosion in their field. The technical measurements, construction, and design of both conservation structures were not based on technical standards of the Ethiopian Ministry of Agriculture (MoA). Recognizing the severity of soil erosion, farmers adopted various conservation strategies in their farmland. Despite high labor, cost, and time requirement of introduced soil conservation measures, farmers enforced to apply their indigenous knowledge to control soil erosion from their farmlands. In most of the area, engineering/mechanical conservation measures were not integrated with biological conservation measures, which contributed to soil erosion in the farmland. The current study shows, various introduced and indigenous soil and water conservation practices identified and documented for further uses.

From the assessment result, it is recommended that, identified indigenous and introduced conservation measures which have a better role in reducing soil erosion in the farmland should be scaled up, during field measurements the implemented conservation measures in the study areas are different in their dimensions. The variation should be proven in the research, and finally, in most parts, the constructed engineering/mechanical measures should be periodically maintained and supported with biological conservation measures.

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