

Research Article

Perception of Farmers on Soil Erosion and Sustainable Land Management Practices in Semen Bench District, Southwest Ethiopia

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Abstract

Soil erosion is a very chronic environmental issue in the agricultural sector in Ethiopia. This study's objective in the Semen Bench district is to assess the perception of farmers on soil erosion and sustainable land management (SLM) practices. The study used a multi-stage sampling method. 124 sample households were selected by systematic sampling techniques. The Likert scale and descriptive statistics were used to analyse the data. Perceived consequences of soil erosion were loss of soil fertility (79%), yield reduction (82.3%), decreased soil depth (50.8%), formation of rills and gullies (45.2%), and soil color change (33.9%) on their farmland, respectively. The results showed the significance of SLM practices, with 32 and 56% of respondents strongly agreeing and agreeing that households could control soil erosion, respectively. The farmers implemented different indigenous and introduced practices to minimize soil erosion and improve soil fertility. The common indigenous SLM practices were contour farming, intercropping, agroforestry, and crop rotation, while introduced practices included stone bunds, fanyajuu terraces, cut-off drains, trenches, bench terraces, and area enclosures, as well as planting different seedling species and Vetiver grass. It can be concluded that SLM is crucial for minimizing soil erosion and improving crop yield. Based on the results, recommendations should focus on encouraging farmers and creating awareness about the application of integrated modern SLM practices.

Keywords

Land Degradation, Perception, Soil Erosion, Sustainable Land Management

1. Introduction

Soil erosion is a significant environmental issue that threatens the agricultural sector. Soil is one of the most important natural resources, as it sustains plants and vegetation that provide food, fibre, and shelter for all living beings [23, 38]. The vital ecosystem services provided to both the environment and humanity underscore the important roles soils

play in the Earth's life-support system [29, 40]. In developing countries like Ethiopia, the sustainable use and management of land resources face significant challenges due to population growth, climate change, and environmental degradation [32, 46]. According to Assen [7] the main causes of land degradation in Ethiopia are rugged topographical features, unus-

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tainable land use, high population pressure, clearing of vegetation, and overgrazing. These significant issues affect the highlands of Ethiopia. According to [16, 17] the average soil loss rate in the upper Blue Nile basin increased from 28.68 to 57.98 t ha⁻¹ yr⁻¹. According to [10], a soil erosion rate of 93 Mg ha⁻¹ year⁻¹ was reported in the Chemoga watershed, whereas [20] reported a rate of 47 Mg ha⁻¹ year⁻¹ in the Koga watershed.

To reverse and control land degradation, restore degraded lands, and guarantee the best possible use of land resources for the benefit of current and future generations, sustainable land management (SLM) must be adopted and funded [30]. Today in Ethiopia SLM is part of climate -resilient green economy strategy, linking soil conservation, afforestation and climate adaption. A SLM program was initiated with agreements signed between the Government of Ethiopia and the World Bank in 2008 to minimize land degradation, increase land productivity, and improve farmer livelihoods [7]. However, despite the government's efforts and its partners to enhance the conservation of natural resources by introducing and promoting SLM practices, the adoption rate remains extremely low [28]. The adoption of SLM practices and farmers' involvement and perception vary by location and household due to various interrelated reasons. Farmers' poor opinion of the introduced SLM practices and limited available resources, such as farmland and high labor requirements, still result in minimal adoption of SLM practices. Semen Bench District is one of the erosion-prone areas in the Benchsheko zone. According to [19] farmers in Geshy sub-catchment basins have been experiencing the effects of severe soil erosion due to a lack of awareness about soil erosion and limited opportunities for active involvement and adoption of soil and water conservation (SWC) methods. To improve agricultural productivity, restoring watershed and mitigate the severity of soil erosion, different SLM practices have been introduced since 2008 through the SLM Program. Additionally, farmers have employed indigenous SLM practices due to awareness created by different institutions working with farmers. Therefore, this study aims to identify and investigate farmers' perceptions on soil erosion and sustainable land management practices, land degradation as well as identifying these practices implemented by the farmers are vital concerns for smallholder farmers in the Semen Bench District, Southwest Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The Semen Bench district in Southwest Ethiopia's Bench-Sheko Zone served as the study site. It is located between latitudes 6°59'0" and 7°3'0" North and longitudes 35°35'0" and 35°42'0" East (Figure 1). The district comprises 23 kebeles and has a total area of 60, 254 km². The study district is bordered by Yeki to the north, Chena to the north-

east, Shay Bench district to the southeast, South Bench woreda to the south, and Mizan Aman town to the west in the Bench Sheko Zone.

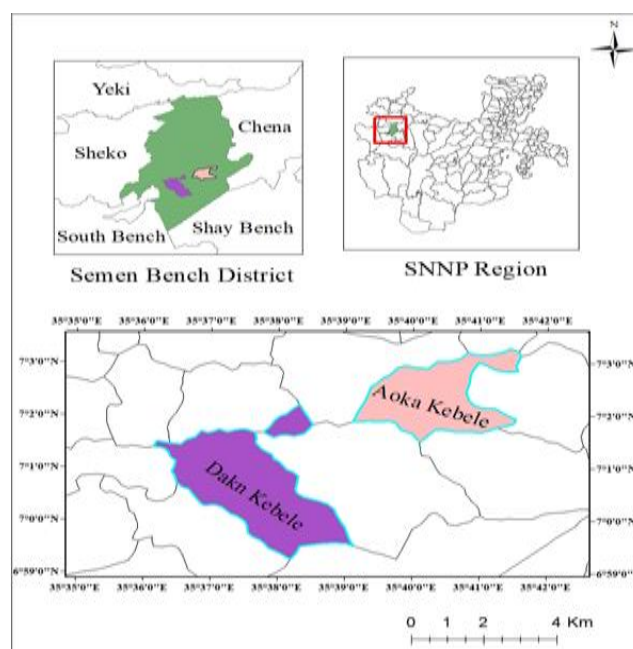


Figure 1. Location Map of the study area.

2.1.1. Topography, Soil Type, and Climate

The topography of Semen Bench woreda is characterized by plains, rugged topography, undulating landscapes, plateaus, and steep slopes. The altitude of the Semen Bench woreda ranges from 1001 to 2500 m above sea level. The climate is dominantly warm and humid, with estimated annual rainfall ranging from 400 to 2000 mm, while the mean annual temperature varies between 15 and 27 °C [21]. Nitisols, Leptosols, and Fluvisols are the dominant soil groups in the study area [14].

2.1.2. Crop Production and Economy

The livelihood of the community is mainly based on a mixed farming system. The crops grown in the study area include maize, mango, coffee, avocado, papaya, and banana. Additionally, root and tuber crops such as sweet potato, enset, and taro are also grown. The main livestock reared in the study area are cattle, sheep, goats, and donkeys.

2.2. Sample Size Determination and Sampling Technique

In this study, a multi-stage sampling method was employed. Semen Bench Woreda was selected purposively due to the occurrence of soil erosion and the widespread implementation of various soil and water conservation practices in SLM projects. Similarly, two kebeles from the district were chosen

based on the study area's adoption of various SLM practices by the SLM and CALM projects. Finally, a total of 124 households were sampled using a random and systematic sampling method. Systematic sampling was efficient because it ensures that the sample is spread evenly throughout the population. Households were selected through a systematic sampling technique, where every K^{th} interval household was selected for each kebele, as the number of households varies from one kebele to another. Then, every K^{th} household head after the first random start was selected until reaching the desired sample size for each kebele. The sample size of respondent households was determined using [13]. Sample size determination formula. From a total of 1172 number of

household heads in the two kebele selected with constituted the sample size 124 households' heads.

$$n = \frac{z^2 pqN}{e^2(N-1) + z^2 pq}$$

Where: n = the number of sample size within, N = the total number of households of the target population; $z=1.96$ (confidence level 95% level of significance); $e=0.05$ (5%, acceptable error margin); $p=0.1$ (proportion of sampled households); $q=0.9$ (estimate of the proportion of households to be sample).

$$n = \frac{1.96^2 * 0.9 * 0.1 * 1172}{0.05^2(1172-1) + 1.96^2 * 0.9 * 0.1} = \frac{405.21}{3.27} = 123.92 \approx 124$$

2.3. Sources and Methods of Data Collection

Primary and secondary sources were the main sources of both quantitative and qualitative data for this study. The primary methods of gathering data were field observation, focus groups, in-depth interviews, and household questionnaire surveys. The questionnaire collected essential socio-economic data, farmers' perceptions, and household respondents' adoption of SLM practices. In each kebele, two focus group discussions with model farmers, youths, and female households were selected from each kebele. Key respondents who were thought to be informed about the many facets of socioeconomic, SLM techniques, and their perspectives were chosen for in-depth interviews. Ten key informants were chosen from district agricultural experts, local community leaders, agricultural extension workers, kebele administrators, and development committees. The secondary data was gathered from various sources such as books, journals, and the internet.

2.4. Data Analysis Method

Version 21 of the Statistical Package for Social Sciences (SPSS) program was used to analyze the numerical data. A descriptive statistical method was employed to determine the percentages and frequencies of various types of SLM practices. Socio-economic continuous variables were analyzed using a t-test, while categorical variables were analyzed using a Chi-square test. The Likert scale was used to analyze the perception of farmers' significance of SLM.

3. Results and Discussion

3.1. Demography and Socio-economic Characteristics of Sample Households

According to the survey results, 92.5% of respondents were male-headed households, while the remaining 7.5% were

female-headed households. There was a significant difference in adopting SLM practices ($p<0.01$). This result is in line with the study of [39] which found that male-headed families had greater access to information about conservation practices than female-headed households, and male-headed households are more likely to implement conservation measures. The survey results also showed that 36.3 and 68.2% of households involved in off-farm activities were adopters and non-adopters, respectively. Table 1 shows that there is a statistically significant negative relationship between household participation in off-farm activities and the implementation of SLM practices ($p<0.01$). This result agrees with the finding of [12] who reported that farmers involved in off-farm activities have lower participation in SLM practices.

Access to extension services for non-adopters and adopters of households was 38.6 and 82.5%, respectively, in the study area. Table 1 shows a statistically significant correlation ($p<0.01$) between households' adoption of SLM practices and their access to extension services. This result is in line with findings by [41] which showed that farmers are more likely to participate in soil and water conservation practices with more interactions with extension agents. The average age of all respondents was 41.48 years, whereas the mean age of non-adopter and adopter respondents was 40.2 and 42.93 years, respectively. The findings showed a statistically significant age difference ($p<0.05$) between adopters and non-adopters of SLM. The mean overall family size per household was 3.08, while the mean family sizes of adopter and non-adopter households were 3.34 and 3.28 members per household, respectively. The results showed a statistically significant difference in family size between adopters and non-adopters of SLM ($p<0.05$) (Table 1). This result agrees with the finding of [26] who reported that farmers with larger family sizes are more likely to implement SLM practices. The cattle holding between the adopter and non-adopter household was 3.14 and 3.42 TLU in ownership of livestock, respectively, while the mean for the total sample was 3.28 TLU. Table 1 shows that there was a statistically significant difference between the adopters and non-adopters in terms of

cattle holding ($p < 0.01$). This implies that farmers with relatively higher ownership of assets and livestock holding tend less to adopt SLM practices than those whose ownership is relatively smaller ownership. This result is in line with findings by [5] who revealed that the higher number of livestock

sizes has a significantly negative influence on the adoption of stone terraces. Similarly, [43] also reported that large-scale cattle ownership has a detrimental impact on land management practice adoption and sustainability due to difficulties in managing and installing feeders.

Table 1. Socio-economic characteristics of sample households.

		Adoption of SLM practice							
Variable		Adopter (N=80)		Non-adopter (N=44)		Total (N=124)		χ^2 -value	P-value
		N	%	N	%	N	%		
Sex	Male	74	92.5	32	72.7	106	85.5	8.94	.003**
	Female	6	7.5	12	27.3	18	14.5		
Education	Illiterate	47	58.8	24	54.5	71	57.3	0.205	0.65
	Literate	33	41.2	20	45.5	53	42.7		
Off farm Activities	Yes	29	36.3	30	68.2	59	47.6	11.6	.001***
	No	51	63.7	14	31.8	65	52.4		
Extension service	Yes	66	82.5	17	38.6	83	66.9	24.5	.000***
	No	14	17.5	27	41.4	41	33.1		
		Mean	SD	Mean	SD	Mean	SD	t-value	
Age		42.93	6.18	40.2	5.79	41.48	5.98	2.56	0.012**
Family size		3.34	1.29	3.28	1.38	3.08	1.33	2.09	0.039**
Farm size		1.98	0.78	1.84	0.96	1.91	0.87	0.84	0.40
TLU		3.14	0.72	3.42	0.63	3.28	0.67	-2.13	0.035**

***, ** and * shows significant at 1%, 5% and 10% level of significance respectively

3.2. Farmers' Perception of Soil Erosion in the Study Area

Most respondents (92.7%) thought that soil erosion was an issue that limited their agricultural production and caused significant land degradation, while the remaining 7.3% did not think that soil erosion was a concern. This result agrees with the finding of [24] who reported that in Ethiopia, an increase in population and extreme precipitation events means soil erosion still remains a significant problem in cultivated land. The primary causes of erosion in the study area, according to farmers, were soil erosion and farming system problems. Most respondents reported that the causes of soil erosion were over-cultivation and deforestation, perceived as the most serious problems in the deterioration of soil resources, with about 85.5% and rugged topography, poor land management practices, very small landholding size, and expansion of Eucalyptus trees, which account for 77.4, 60.5, 36,

and 38.7%, respectively, especially susceptible to increased soil erosion, which worsens soil degradation in the study area (Table 2). In the study area, farmers widely plant Eucalyptus tree seedlings around cultivated land, which can decline soil fertility, reduce infiltration, and increase runoff, consequently accelerating soil erosion.

The farm households' perceptions of the consequences of soil erosion, as reported by the respondent farmers, were about 79, 82.3, 50.8, and 45.2% identified loss of soil fertility, yield reduction, decrease in soil depth, and formation of rills and gullies erosion, respectively, in the study area. While 33.9% of the respondents perceived soil color change to yellowish color due to the removal of the top fertile soil by soil erosion as a consequence of soil erosion. This result is in line with findings by [11] who found that farmers in the Lake Awassa watershed and the Omo-Gibe basin perceived the consequence of soil erosion to be a decline in crop yield. Among the total respondents, their perception of the rate of soil erosion on their cultivated land was 36.3% of farmers perceived it as

severe, 42.7% as moderate due to the recent implementation of SLM projects that paid laborers to work in the study area, 13.7% as minor, and 7.3% did not perceive erosion as a problem on their cultivated lands (Table 2). 95.2% of households believed that soil erosion can be minimized on their farm plots. The application of modern SLM practices such as grass strips, improved cut-off drains, Fanyajuu, and others is highly effective in minimizing soil erosion. This result is

supported by the findings of, [35] which showed that the implementation of soil and water conservation measures reduced runoff and soil erosion while increasing land productivity in the Akusti micro-watershed in northwest Ethiopia. Similarly, [9] claimed that several water and soil conservation techniques can be used to improve water conservation, increase soil and water productivity, and combat nutrient depletion and soil erosion.

Table 2. Farmer's perception of soil erosion, cause, Erosion Severity level and Consequences.

Variable	Description	N	%
Soil erosion problem on your farm	Yes	115	92.7
	No	9	7.3
Cause of soil erosion	rugged topography	96	77.4
	over cultivation and grazing	106	85.5
	poor land management practices	75	60.5
	very small land holding size	45	36
	Deforestation	106	85.5
	Expansion of Eucalyptus Trees	48	38.7
	severe	45	36.3
Erosion Severity level	Moderate	53	42.7
	minor	17	13.7
	No erosion problem	9	7.3
	yield reduction	102	82.3
Consequences of erosion	Decline in soil fertility	98	79
	Gullies and rills formation	42	45.2
	decrease soil depth	63	50.8
	soil color change	56	33.9
Do you think that erosion can be controlled?	yes	118	95.2
	No	6	4.8

3.3. Farmers' Perception Significance of SLM Practices

Respondents' perception towards the significance of SLM was measured using a five-point Likert scale, in which a value of 1 to 5 was assigned for farmers' perceptions of strongly agree, agree, neutral, disagree, and strongly disagree, respectively. Farmers were requested to reveal and rate their own personal and subjective judgment or perception towards SLM based on 5 perception statements. Farmers' perception of SLM practices significantly contributes to the adoption of the practice for the environmental and socio-economic benefits of households.

According to focus group discussions, informants were interviewed to understand their perception of the effectiveness of SLM practices in controlling soil erosion on their farms. The results indicated that, shown in Table 3, about 32 and 56% of households strongly agreed and agreed, respectively, that soil erosion could be controlled. This result agrees with the finding of [45], who reported that implemented land management practices over a period of five years, achieved through the mobilization of community labor, resulted in efficient soil erosion control in selected watersheds. Table 3 shows that about 25 and 58% of households strongly agreed and agreed, respectively, that the adoption of SLM practices increases crop yield. The result is in agreement with the findings of, [3, 6] who

reported that compost and mineral fertilizer together enhanced agricultural productivity by 54 to 60% in southern Ethiopia. In contrast, [1, 2] also reported that terraces, such as soil bunds, stone bunds, and Fanyajuu, have a short-term negative effect on agricultural yield due to reduced farmland.

A moderate proportion of the respondents, 64%, agreed with the perception that SLM plays a role in improving soil fertility. Focus group discussions revealed that the use of

several SLM practices, such as crop rotation, intercropping, crop waste, manure, compost, and increases soil fertility. This result is in line with the findings of [4] who reported that terraces have a strong positive effect on increased soil fertility, improved moisture status, and increased crop yield. Similarly, [36] also reported that farmers widely practiced newly introduced SWC practices due to their positive perception and acceptance in the northern part of Ethiopia.

Table 3. Distribution of respondents based on their Perception scale (n=124).

Perception	Level of agreement									
	SA		A		N		DA		SDA	
	n	%	n	%	n	%	n	%	n	%
Control soil erosion	40	32	69	56	5	4	8	6	2	2
Increase crop yield	31	25	72	58	10	8	6	5	5	4
Improve soil fertility	23	19	79	64	12	10	6	5	4	3
Increase vegetation cover	24	19	74	60	14	11	7	6	5	4
Improve land productivity	27	22	81	65	5	4	4	3	7	6

SDA= Strongly Disagree, DA= Disagree, N= Neutral, A= Agree, SA= Strongly Agree

3.4. Major Type Sustainable Land Management Practices

3.4.1. Indigenous / Traditional / Sustainable Land Management Practices

Farmers in Semen Bench woreda have been practicing different SLM practices to maintain the stability of their environment and improve soil productivity, from which they obtain their livelihoods. Figure 2 shows that farmers adopt different indigenous practices, such as contour farming, intercropping, agroforestry, and crop rotation, based on their indigenous knowledge, to improve the productivity of their land and control soil erosion.

Crop rotation: One of the most common traditional activities after harvesting one crop is planting another crop. Figure 2 shows that about 91.5 and 89.2% of respondents in Aoka and Dakn Kebele, respectively, practiced crop rotation. This result agrees with the findings of [44], who reported that crop rotations, which include nitrogen-fixing leguminous crops in cropping sequences for increased yield, are well-known Ethiopian farming techniques.

Intercropping: The indigenous practice of cultivating two or more crops on the same plot of land at the same time is known as intercropping. Figure 2 shows that about 64.5 and 68% of the respondents in Aoka and Dakn Kebele, respec-

tively, implemented intercropping to enhance soil fertility. This result is in line with, [25], who also reported that intercropping can help regulate water dynamics in addition to enhancing soil nutrients.

Agroforestry: Agroforestry is the practice of planting and caring for trees or shrubs in pasture and/or farmland areas to obtain the benefits of integrated land-use systems that are both ecologically sound and economically viable. Figure 2 shows that about 72.9 and 69.2% of the respondents in Aoka and Dakn Kebele households, respectively, employed agroforestry to control runoff and soil erosion and achieve food security. This result is in agreement with the findings of, [42] who also found that agroforestry methods are rapidly spreading over Ethiopia's southeastern rift escarpment, significantly improving soil fertility, access to water and fodder, and maintaining ecological balance. Similarly, [33] reported.

Crop residues: One indigenous practice common in the area is leaving crop residues on cultivated land after harvesting crops. Figure 2 shows that about 33.9 and 38.5% of households in Aoka and Dakn Kebele, respectively, leave crop residues on cultivated land, such as straw and maize stalks, which helps minimize runoff and erosion, improve infiltration rates, and maintain soil fertility. This result is consistent with, [15] who demonstrated that crop residue retention on farm plots improves the soil's fertility status by shielding it from the destructive impacts of wind and heavy rains and by preserving moisture.

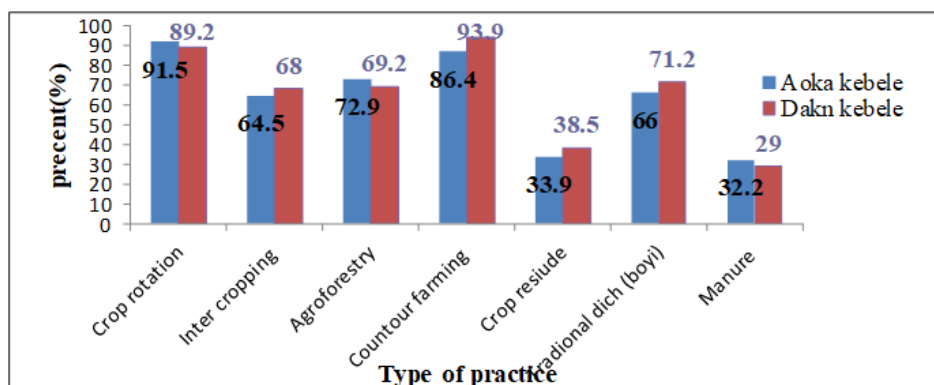


Figure 2. Indigenous / tradional/ sustainable land management practices

3.4.2. Introduced / Modern / Sustainable Land Management Practices

Major introduced SLM practice study area included stone bund, fanyajuu terrace, cut off drain, trench, bench terrace, area enclosure, and seedling planting.

Stone bund: A stone bund is an embankment that was constructed along the contour and across the slope. Figure 3 shows that about 52.5 and 61.5% of the households in Aoka and Dakn Kebele, respectively, were employed stone bund structure. It is used to increase soil moisture and decrease erosion. The result was in line with the findings of [27] who found significant differences in the adoption and non-adopter of stone bunds on crop production in Northern Ethiopia. In contrast [2, 22] found that soil and stone bunds in Ethiopia negatively affect crop yields due to reduced cultivable land size.

Fanya juu bund: Fanya juu is a soil and stone embankment with a channel at its lower side for collecting overflowing runoff. Figure 3 shows that 32.2 and 38.5% of the respondents in Aoka and Dakn Kebele, respectively, are implementing Fanya juu practices. This result agrees with the findings of, [47] who reported that the Fanya juu application boosted agricultural productivity in both western and southern Ethiopia by increasing soil fertility. Trenches are structures built on cultivated farmland to drain excess water and reduce erosion/runoff. Constructing trenches reduces the rate of runoff, increases the percolation rate, and increases soil moisture for vegetation. Figure 3 shows that about 25.4 and 21.5% of the respondents in Aoka and Dakn Kebele, respectively, implemented trench structures. Area enclosure is a practice where about 42.4 and 49.2% of households in Aoka and Dakn Kebele, respectively, contributed to beekeeping and hay production, improving vegetation cover and increasing biodiversity, as shown in Figure 3. This outcome supports the findings of [34, 48] who found that area enclosures effectively enhance nutrient content and soil qualities.

Bench terrace: A bench terrace is a type of conservation structure in which a slope is converted into a series of gentle slopes for growing different perennial crops. Figure 3 shows

that about 18.6 and 21.5% of households in Aoka and Dakn Kebele, respectively, adopted bench terraces. This result agrees with the findings of, [37] who reported that bench terraces employed on steep slopes have a positive effect on agricultural productivity in Kiambu, Meru, and Machakos districts in Kenya. Similarly, [31] reported that SLM is crucial for minimizing land degradation, rehabilitating degraded areas, and ensuring the optimal use of land resources for the benefit of present and future generations.

Planting grasses and seedlings: One of the primary biological soil and water conservation strategies is the planting of grasses and seedlings, which mostly entails planting trees and grasses. Grass species like Desho grass, vetiver grass, and elephant grass are among the most commonly implemented on farmland. Figure 3 shows that about 57.6 and 63% of the respondents in Aoka and Dakn Kebele, respectively, used these grasses to improve soil fertility, reduce runoff erosion, minimize erosion, and generate income. This result is in line with the findings of [18] who reported that vetiver grass plays a significant role in reducing soil erosion, improving soil fertility, and conserving moisture in Ethiopia. Similarly, according to [8] grass or shrub strips stabilize the terracing of farm plots and provide nourishment for animals.

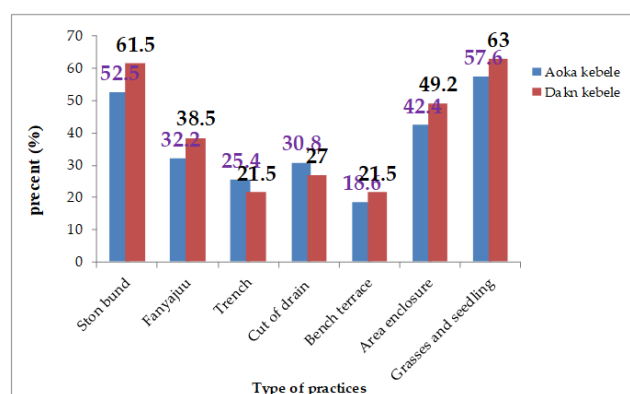


Figure 3. Introduced/Modern/ SLM practices.

4. Conclusion and Recommendation

One of the main environmental issues threatening the agriculture sector is soil erosion. The perceived causes of soil erosion were deforestation, overgrazing, rugged topography, poor land management practices, and very small landholding size. The consequences of soil erosion perceived by the respondent farmers were loss of soil fertility (79%), yield reduction (82.3%), decreased soil depth (50.8%), formation of rills and gullies (45.2%), and soil color change on their farmland (33.9%). According to the farmers, soil erosion is an issue that can be controlled by implementing integrated SLM practices. The application of various SLM techniques could be extremely important in boosting agricultural output, reducing soil erosion, enhancing soil fertility, ensuring food security, and improving smallholder farmers' standard of living. Based on these findings, it is recommended that farmers be encouraged and motivated to apply integrated practices and be made aware of the effects of adopting SLM practices.

Abbreviations

SLM	Sustainable land Management
SWC	Soil and Water Conservation
CLAM	Climate Action Land Management

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Author Contributions

Assen Yesuf Ali is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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Research Fields

Assen Yesuf: Natural resource management, Watershed management, soil fertility, soil science, Agricultural science, Environment science, Soil and water conservation