

Research Article

Sustainable Agricultural Management of Land Using Technology for Soil and Water Conservation within the Central Rift Valley, Central Ethiopia

Tesfaye Birhan and Wondimagegnehu Tekalign 

College of Natural and Computational Sciences, Department of Biology, Wolaita Sodo University, Wolaita Sodo, P. O. Box 138, Ethiopia

Correspondence should be addressed to Wondimagegnehu Tekalign; wondimagegnehubeyene@gmail.com

Received 15 September 2021; Revised 22 March 2022; Accepted 2 September 2022; Published 10 September 2022

Academic Editor: Mahmoud Nasr

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Ethiopia has used several techniques for conserving water and soil. However, different sociocultural and technical problems have been affecting their implementation. The study is aimed at assessing sustainable agricultural management of land implementations through traditional and modern conservation of soil and water technologies in the central Rift Valley, Ethiopia. The research approach used was a descriptive survey using a cross-sectional research design. Household heads were chosen at random from the three kebeles, while representatives were chosen using a proportionate sample technique. Furthermore, kebeles and key informants were selected by using a purposive sampling technique. Data were collected through questionnaires, key informant interviews, and field observation. The results show that both traditional and contemporary methods for conserving soil and water have advantages and disadvantages of their own, and some of them have been combined. A number of factors, including age, family size, education, topography, distance from the homestead, income, and the availability of training, have a big impact on whether or not soil and water conservation methods are adopted. The majority of farmers use mixed farming followed by crop production to meet their livelihood needs. The most widely implemented physical measure was terracing, followed by stone bunds. The farmers practiced traditional waterways, furrows, check dams, terracing, and stone bunds as traditional conservation practices. Agroforestry, followed by grass strip and area closure, was the most commonly implemented vegetative measure. Besides, animal manure, followed by animal parking, was the most implemented agronomic measure. The concerned stakeholders need to pay more attention to community mobilization for the conservation, upkeep, and development of traditional and modern soil and water conservation structures. In order to employ traditional and contemporary soil and water conservation measures for sustainable agricultural land management practices, experts need to instruct the local farmers.

1. Introduction

Soil, water, vegetation, and animal resources are all managed as part of sustainable land management [1]. Policies that support sustainable land management are required to advance and address the complexity of sustainable land use, particularly those that offer incentives for investments in sustainable land management at the household, community, regional, and national levels. In addition to addressing the underlying causes of soil erosion, low production, and food insecurity, policies must

provide socially acceptable means of incentive or enforcement [2].

Land is Sub-Saharan Africa's most valuable asset. It contains a rich biodiversity of soils, plants, water, and genetic variability in its natural ecosystem resources. They comprise the natural capital of the area on the mainland as a whole. These resources supply essential ecological services, preferred meals, food, water, timber, fiber, and industrial products [3]. It is necessary to design adequate soil conservation techniques that address all types of soil degradation processes in connection to agricultural systems in

agroecological zones if soil resources are to be exploited for sustainable agricultural output [4].

According to reports, in Sub-Saharan Africa, Ethiopia has the greatest rates of soil nutrient depletion as a result of soil erosion [5, 6]. The most serious issue brought on by the improper use of agricultural management strategies is soil erosion [7]. The main causes of soil erosion in Ethiopia are overgrazing, farming on sloping terrain, removing vegetation, and rapid population growth [8]. Water-induced soil erosion has a negative influence on the nation's food supply [9], soil fertility and agricultural output [10, 11], environmental sustainability [12], downstream floods and reservoir sedimentation [13, 14], and plant nutrient loss [15–17]. Nutrient loss in agriculture has increased as a result. Due to the decreased agricultural yield and increased cost of replacement, farmers lose money as a result of this property [18, 19]. According to Belay [2], the majority of farmers in Ethiopia cultivate sloppy, marginal areas that are especially vulnerable to soil withdrawals. Many civilizations in developing nations are migrating to the highlands because of favorable ecological and farming conditions, creating extraordinary populations that contribute to resource destruction [20]. As a result, Ethiopia is one of the nations with the worst conditions. In Ethiopia, small-scale farming practices are mostly to blame for the depletion of soil and water resources. The most pressing environmental problem facing the nation is the depletion of natural resources [21]. Traditional land management techniques can be made more sustainable by fusing newly learned modern technologies with indigenous knowledge and behaviors of land users [2, 22]. In order to fulfill the growing demand for food in the coming decade, agriculture will need to produce more food on a smaller amount of land while simultaneously using more natural resources effectively and having a less negative impact on the environment [23].

Different soil and water conservation strategies have been used in the research region over the past few years. A large number of terraces, bunds, deep wells, ponds, and diversion ditches have been built to stop soil erosion, improve soil fertility, and guarantee the local farmers' access to food. Nonetheless, due to a lack of well-established standards, structures built without the assistance of skilled men or development agents, and measures implemented without taking into account the slope of the land, may end up causing high degradation and flooding rather than conserving the land. The consequence of this is that the farmland's productivity declines over time. Therefore, it is crucial to integrate applicable indigenous and contemporary soil and water conservation methods and assess their effects on the sustainability and production of the land along with environmental protection in the research area in order to address the current issues. Finally, this research will provide an alternative solution for policymakers and planners, as well as a baseline for other scholars to conduct further research and assist farmers and other interested parties in developing their attitudes and knowledge in order to improve land resource management practices.

Based on the aforementioned issue, the following fundamental research topics were put forth:

(1) What are the primary conventional and contemporary methods of soil and water conservation in the research area? (2) What are the main traditional and contemporary soil conservation techniques that have been applied in the study area? (3) What is the local population's opinion of both conventional and cutting-edge soil and water conservation techniques? Besides, (4) What key elements determine the effectiveness of conservation efforts for soil and water? This study is anticipated to fill in any gaps and offer potential answers to the study area's current soil and water conservation-related issues. The study's specific goals were to identify the most significant traditional and modern soil and water conservation practices; assess the integration of traditional and modern soil and water conservation technologies; look into the attitudes of the local population toward traditional and modern soil and water conservation technologies; and look into the determinant factors influencing soil and water conservation measures for the long-term agricultural land management in the Central Rift Valley of Ethiopia.

2. Materials and Methods

2.1. The Study Area. The study was carried out in Ethiopia's Adama district, East Shewa Zone, and Oromiya Region. It was located 100 km southeast of Addis Ababa. The Amhara Region (Debre Tsehay Kebele) is bounded to the north by the district, to the south by the Arsi zone, and to the west and east by the Lume and Boset districts, respectively (Figure 1). The district has a total area of around 170,663 hectares. From the total area, 27,685 (16.2%) ha was cultivated land, 11,282 (6.61%) ha was uncultivated land, 5,220 (3.05%) ha was forest-covered land, and the rest, 118,781 (69.6%) ha, was grazed land, and 8,050 (4.7%) ha of the land was homestead. Traditional agroclimatic zones of low land (Kolla) (78.37%) and midland (Woina Dega) (21.62%) can be used to categorize the research area. The research area's maximum and minimum temperatures are 33°C and 12°C, respectively. The annual rainfall ranges from 650 mm to 1150 mm. The rural kebeles (the smallest administrative unit) have slightly different climatic conditions due to changes in relief, natural vegetation cover, and other physical reasons.

Native acacia-dominated forests predominate in the Central Rift Valley of the East Shewa Zone, a very vulnerable ecosystem adapted to semiarid conditions with fluctuating rainfall [24]. The major wild animals found in the study area are hyenas, foxes, monkeys, and other wild animals, including various avian species. The research areas predominant soil types include sandy (45%), loam (25%), clay (5%), and silt (25%). The Adama District has a total population of 167,726. Among these, 86,311 (51.45%) are male, and the remaining 81,415 (48.54%) are female. The number of households is 21,025 (i.e., 15,778 are male, while 5,247 are female household heads). The majority of the populace relies on mixed farming (crop production and livestock rearing). Wheat, barley, peas, and beans are the dominant crops grown by the local farmers. Crop production is also affected by environmental degradation and the loss of soil fertility. More than any other technique, farmers employ animal

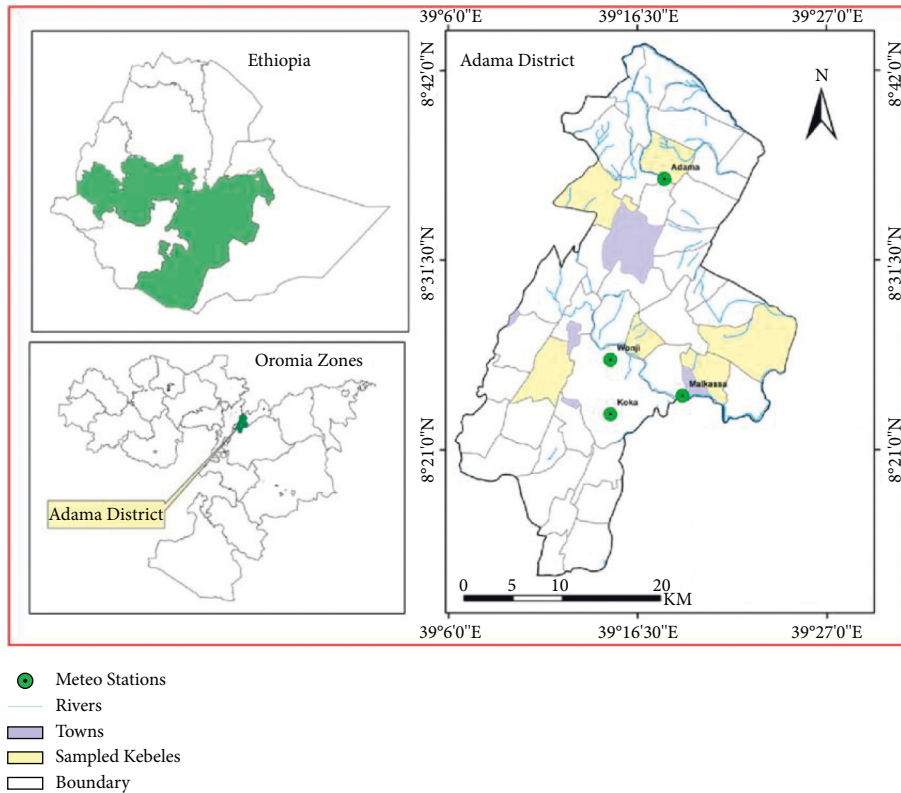


FIGURE 1: Location map of the study area.

dung and chemical fertilizers to increase the fertility of the soil. The rural population is also engaged in livestock rearing, such as cows, sheep, goats, donkeys, and hens. The farmers sell animal products like butter, milk, honey, and eggs as a source of income generation.

3. Methods

The study was carried out in Oromiya Regional State's Adama District. There were 37 kebeles (the smallest administrative unit) with two major agroecological zones, such as low land (29 kebeles) and midland (seven kebeles), which practiced similar agricultural activities in their surroundings. Then, three kebeles were selected, two from low land, namely, Awash Melkasa (with 83 households) and Humo Fechasa (with 61 households), and one from midland, namely, Ajersa (with 188 households), and through personal contacts, based on criteria of availability, profession, and representation of stakeholders, twelve key informants from different groups of the community development agents (1), kebele leaders (1) from each kebele, and community elders (2, 1, and 3, respectively) from each kebele, totaling four from Awash Melkasa, three from Humo Fechasa, and five from Ajersa, were chosen via a selective sampling strategy. The main reasons for the selection of these three kebeles were related to land degradation, the difficult nature of the topography, time and budget constraints, and proximity. The total number of households in these three kebeles was 1951. Of these, 1909 were males, and 42 were females. As a result, a simple random selection (lottery) technique was

used to pick 332 (17.02%) head farmer homes from the total households (Table 1).

This study employed a cross-sectional research design with a survey method. The rationale behind it involved data collection pertaining to the integration of technologies for water and soil conservation from a sample population or representative subset at one specific point in time. Physical, vegetative, agronomic, and soil fertility management were the four categories used in this study to classify traditional soil and water conservation approaches. Modern soil and water conservation techniques include fanyajuu terraces, cut-off drains, check dams, hillside terracing, and soil and stone bunds. It was concerned with describing the characteristics of an event and specific predictions with narrations of facts and characteristics of a situation. The data was interpreted using quantitative and qualitative approaches. In qualitative approaches, interview data and field observations were described and incorporated into the analysis. Both primary and secondary data sources were employed to achieve the research's principal objective. The farmer's household survey, community leaders, development professionals, district soil and water conservation specialists, and district and zonal agricultural experts served as the main data sources. It was collected by using different instruments, such as both open and closed-ended questionnaires, interviews conducted through a semistructured interview, and direct field observation. The study's secondary sources included books, journals, project reports, research papers, census records, newspapers, and online sources, as well as public and unpublished documents linked to the study. The

TABLE 1: A sample of households from the selected kebeles.

Rural kebele's	Agroecology	Total households			Sampling households		
		Male	Female	Total	Male	Female	Total
Ajersa	Midland	1095	9	1104	182	6	188
Humo fechasa	Low land	338	16	354	49	12	61
Awash melkasa	Low land	476	17	493	70	13	83
Total		1909	42	1951	301	31	332

data was examined using SPSS (version 20), which was then interpreted quantitatively and qualitatively. Descriptive statistics like percentage frequency were emphasized. To analyze the factors that affected soil and water conservation technologies, inferential statistics like Chi-square (χ^2) were used.

4. Results

The survey result indicated that, out of 332 sample household heads, 90.7% of them were male, while the remaining 9.3% of the households were female. This demonstrates the stark disparity between the proportion of male and female household heads. It has been amply demonstrated that there are gender differences in the adoption of technology for soil and water conservation. The vast majority of respondents (76.2%) were married when it came to marital status. The remaining respondents were single (14.8%), divorced (7.5%), and widowed (1.5%), respectively. Regarding the respondents' educational backgrounds, 49.1% of them are illiterate in both reading and writing. Only 15.6% of them are enrolled in formal education at the elementary school level or higher, and 35.2% of them are literate and can write (Table 2). In the study area, uneducated respondents made up the majority. Educational attainment is one of the demographic traits of families that are crucially important to raising awareness of environmental concerns, including the causes and effects of soil erosion and conservation methods.

About 4.3% of the respondents were within the 15–24 age categories; 49.2% of them were between 25 and 34; 22.2% were within 35–44; 19.3% were between 45 and 54; and 4.8% of the respondents were 55–64 years old. Regarding the family size of the respondents, 28% of them have 1–3, many of them (57%) have 4–6, 13% have 7–9, and only 2% of the respondents have a 10–12 family size (Table 2). This shows that the majority of household heads have families that are large enough to have an effect on the adoption of soil and water conservation techniques. About 5.4% of those polled had lived in the study area for 19 to 24 years, 19.5% for 25–30 years, and 75.1% for 30 years or more. Almost all of the household respondents have their own land. From the total sample households, 47% had 0.1–1.0 ha of the land area, 27.7% had 1.1–2.0 ha, 14.5% of respondents had between 2.1 and 3.0 ha, about 6.9% had between 3.1 and 4.0 ha of the land, and the remaining 3.9% of the households had more than 4.0 ha of the land (Table 2).

According to the interview with developmental agents, those who own a significant size of the farmland have positive views about soil and water conservation measures, whereas those who own a small size of the farmland have

negative attitudes. The adoption of soil and water conservation buildings is also impacted by the slope of the farmlands because a steeper slope would result in a higher rate of soil erosion. Each agricultural plot is divided into three categories: mountainous (extremely steep slope ($>20^\circ$)), steep slope (3° to 20°), and flat, gentle slope (inclinations $<3^\circ$) based on the perception of households and the assessment of developing agents. Thus, about 66% ($n=219$) of the study area was steep, 29% ($n=96$) was gentle, and 5% ($n=17$) of the household's farm plot was a very steep slope.

The majority of the respondents ($n=273$, or 82.2%) rely on mixed farming, or the cultivation of both crops and animals, to meet their basic needs. The proportion of others who were engaged in mixed farming, followed by crop production, was 8.1% ($n=27$), crop production and petty trade was 3.6% ($n=12$), livestock production and petty trade, and mixed farming and petty trade each accounted for about 3% ($n=10$).

Farmers in the study area have been using a variety of conventional soil and water conservation techniques to reduce soil erosion. The most widely implemented physical measure was terracing (76.2%), followed by stone bunds (62%). Besides, 60.5% of the respondents practiced traditional waterways, 57.2% of them furrow, 49.1% of them traditional check dams, 42.8% practiced terracing, furrows, and stone bunds and 38.9% of them practiced traditional waterways, terracing, and stone bunds, as traditional conservation practices. The farmers were practicing building soil bunds for erosion control in the sloppy area. The most prevalent technique in the research area was stone terracing, which was done on the steep, bare, degraded soil. Respondents said that individuals have built stone and soil bunds in the research area, particularly around the mountain area. These structures are barriers of stone or soil, or a combination of these two.

Regarding vegetative measures, a significantly large proportion of the respondents (79.8%) replied that they engage in the planting of various types of plants for the purpose of aiding soil conservation indirectly. Agroforestry (51.2%), grass strip (45.5%), area closure (41%), and planting trees, area closure, and agroforestry (19%) were found to be the most commonly implemented vegetative measures in the study area. As the key informants responded, most of the farmers had inadequate awareness of the importance of agroforestry. Besides, the area's closure was disrupted by human and animal interference.

As far as the agronomic measures go, animal manure was the most implemented (84.9%), followed by animal parking (70.2%). Mixed cropping was also practiced by a significant

TABLE 2: Social and economic data on the respondents.

Variables	Categories	Frequency	Percentage
Sex	Males	290	87.3
	Females	42	12.7
Age/year	15–24	14	4.3
	25–34	163	49.2
	35–44	74	22.2
	45–54	65	19.5
	55–64	16	4.8
Marital status	Married	253	76.2
	Single	49	14.8
	Divorced	25	7.5
	Widowed	5	1.5
Educational status	Unable to read and write	163	49.1
	Grades 1–4	117	35.2
	Elementary school (grades 5–8)	27	8.1
	Secondary school (grades 9–10)	18	5.4
	Preparatory school (grades 11–12)	—	—
	Above 12th grade	7	2.1
Household size	1–3	93	28.0
	4–6	189	57.0
	7–9	43	13.0
	10–12	7	2.0
Landholding size	0.1–1.0 ha	156	47.0
	1.1–2.0 ha	92	27.7
	2.1–3.0 ha	48	14.5
	3.1–4.0 ha	23	6.9
	>4.0 ha	13	3.9

proportion of household heads (67.2%), and 63.8% of the household heads practiced mixed cropping and animal manure. Crop rotation was the most important soil fertility management measure (73.5%) in the study area, followed by weed heap (64.8%), crop residue (51.8%), and both crop rotation and crop residue (44.3%). However, a small proportion of the respondents (21.7%) admitted the following (Table 3).

90.7% of the respondents agreed that traditional soil and water conservation methods or technologies complimented one another, while 94.6% thought they restored degraded land, 82.2% thought they were flexible, and 74.7% thought they required little capital. The majority of responders (88.6%) concurred that the traditional soil and water conservation technologies are labor-intensive, followed by being affected by relief type (80.4%), environmentally non-friendly (24.4%), affected by land fragmentation (66.6%), affected by physical endowment (71.4%), and may contribute to erosion (9.6%) (Table 4).

According to the key informants, traditional soil and water conservation techniques have many benefits because they can help restore degraded land, require little capital, and work in tandem. However, when farmers implement these techniques without taking into account the slope of the land, they risk damaging the land rather than conserving it. The most widely used technologies were soil bund (30.1%), stone bund (38.9%), modern terracing (25.9%), cut-off-drain (36.1%), check dam (24.4%), hillside terracing (28.6%), Fanyajuu terraces (22.3%), and soil and stone bunds (42.2%) (Table 5).

The majority of the respondents agreed on the strengths of modern technologies. Approximately 89.2% and 84.9% agreed that modern soil and water conservation techniques increase agricultural production and soil fertility, respectively. Most of the respondents (82.8%) agreed that modern techniques for conserving soil and water involve expert knowledge; 78.9% facilitate Sustainable Land Management (SLM); and 51.8% may not be affected by fragmentation. However, the respondents also disagreed with the idea of modern soil and water conservation technologies as saving time and energy (38.0%), increasing agricultural production (10.8%), involving expert knowledge (17.2%), not being affected by fragmentation (48.2%), facilitating sustainable development (21.1%), and increasing soil fertility (15.1%) (Table 6). Based on the respondents' perception, the major limitations of modern soil and water conservation technologies were the demand for large amounts of capital (76.2%), the effect on soil microbes (71.4%), and the cause of environmental pollution (67.5%). Furthermore, these technologies have been imposed by the government (59.0%) and disregard the local indigenous knowledge (52.4%).

The most widely practiced integrated approach was the application of organic manure side by side with chemical fertilizer (76.5%). Farmers have reported that they were highly enforced by the government to buy chemical fertilizer in cash. However, they preferred organic manure to enhance the fertility of their soil. The farmers were using animals' manure on their farmland and also adding a small amount of chemical fertilizer to the same plot at the same time. This minimizes the expense of purchasing fertilizer and keeps the

TABLE 3: The traditional soil and water conservation measures used in the study area.

Broad categories	Specific categories of soil and water conservation	Frequency	Percentage
Physical measures	Traditional stone bunds	206	62.14
	Traditional check dam	163	49.1
	Furrows	190	57.2
	Traditional waterways	201	60.54
	Traditional terracing	253	76.22
	Traditional waterway, terracing, stone bund	129	38.9
	Stone bunds, furrows, and terracing	142	42.8
Vegetative measures	Grass strips	151	45.48
	Planting trees	265	79.8
	Area closure	136	41
	Agroforestry	170	51.2
	Planting trees, area closure, and agroforestry	63	19.0
Agronomic measures	Mixed cropping	223	67.2
	Animal manure	282	84.9
	Animal parking	233	70.2
	Mixed cropping and animal manure	212	63.8
Soil fertility management measures	Fallowing	72	21.7
	Crop rotation	244	73.5
	Crop residue	172	51.8
	Weed heap	215	64.8
	Crop rotation and crop residue	147	44.3

TABLE 4: The role of traditional soil and water conservation practices.

Category	Description	Response from respondents			
		Agree		Disagree	
		Frequency	Percentage	Frequency	Percentage
Strength	Complement each other	301	90.7	31	9.3
	Help to restore degraded land	314	94.6	18	5.4
	Flexibility	273	82.2	59	17.8
	Employ local knowledge and tools	248	74.7	84	25.3
	Demand low capital	294	88.6	38	11.4
Weakness	Laborious	267	80.4	65	19.6
	Affected by relief	81	24.4	251	75.6
	Environmentally non-friendly	221	66.6	111	33.4
	Affected by land fragmentation	237	71.4	95	28.6
	Affected by capital endowment	32	9.6	300	90.4

TABLE 5: The most recent soil and water conservation technologies in the study area.

Modern soil and water conservation technologies	Frequency	Percentage
Modern soil bund	100	30.1
Modern stone bund	129	38.9
Modern terracing	86	25.9
Cut-off-drainage	120	36.1
Check dam	81	24.4
Hillside terracing	95	28.6
Fanyajuu terraces	74	22.3
Soil bund, stone bund, cut-off drain, and check dam	36	10.8
Soil and stone bunds	140	42.2

land fertile too. They also apply crop residue and mulching together (69.0%). Stone bund or gabion integrated with a check dam was applied by about 51.8% and mixed cropping with agroforestry by 49.1% of the households (Table 7). As we have seen in the table, 44.3% of the households' integrated crop rotation with strip cropping, 43.7% of them

weeded with compost, 42.8% of them local breeding with selective breeding, and the rest (40.1%) controlled grazing with a grass strip.

The level of integration of the remaining land management measures was insignificant in the rest of them, such as organic manure with chemical fertilizer and crop residue

TABLE 6: The role of modern soil and water conservation technologies.

Category	Description	Response of sample respondents			
		Agree		Disagree	
		Frequency	Percentage	Frequency	Percentage
Strength	Increase soil fertility	282	84.9	50	15.1
	Increase agricultural production	296	89.2	36	10.8
	Involved expertise knowledge	275	82.8	57	17.2
	May not be affected by fragmentation	172	51.8	160	48.2
	Save time and effort	206	62.0	126	37.8
	Facilitate long-term land management	262	78.9	70	21.1
Weakness	Demand for large capital	253	76.2	78	23.78
	It could affect soil microbes	237	71.4	95	28.6
	Can cause environmental pollution	224	67.5	108	32.5
	Disregard local knowledge	174	52.4	158	45.56
	Imposed by the government	196	59.0	136	41.0

TABLE 7: How traditional and modern soil and water conservation technologies have been integrated.

Integrated with soil and water conservation technologies	The response of the sample HHS	
	Frequency	Percentage
Organic manure with chemical fertilizer	254	76.5
Stone bund/gabion with check dam	172	51.8
Mixed cropping with agroforestry	163	49.1
Crop residue with mulching	229	69.0
Crop rotation with strip cropping	147	44.3
Weed heap with compost	145	43.7
Local breed with selective breeding	142	42.8
Controlling grazing with a grass strip	133	40.1
Organic manure with chemical fertilizer and crop residue with mulching	102	30.7
Organic manure with chemical fertilizer and mixed cropping and agroforestry	74	22.3

with mulching (30.7%) and organic manure with chemical fertilizer and mixed cropping with agroforestry (22.28%) compared to others. The lack of integration of land management measures, according to key informants, is attributable to labor shortage, a lack of endowments such as cattle and capital, land fragmentation, a lack of knowledge, and a lack of awareness.

The attitude of the local people towards techniques for conserving soil and water could have an impact on those measures in the area. Studying land users' perceptions and attitudes towards techniques for conserving soil and water is essential in the analysis of farmers' adoption and continued use of the technologies. Those farmers who have a negative attitude towards contemporary techniques for soil and water conservation tend to resist the adoption of this kind of measure. However, people with a positive outlook are more likely to put these conservation efforts into effect.

The majority of farmers (52.4%), however, did not adopt and apply integrated soil and water conservation strategies. Most of the respondents (83.1%) have a positive attitude towards soil and water conservation techniques, and the rest of them (16.9%) have negative attitudes in the study area. Most farmers (79.5%) said that these techniques for soil and water conservation are employed to decrease soil erosion; 10.8% said they boost land and soil production; 5.4 percent said they do not impose barriers to tillage and other crop

management operations; and 4.22 percent said they reduce water pollution (Table 8).

Farmers' choices of conservation measures and their decisions to invest in soil and water conservation activities are influenced by a number of factors, both favorably and adversely. 8.1% of the respondents replied that age is a factor in the farmer's conservation decisions. Age and water and soil conservation practices have a very substantial link ($\chi^2 = 11.400$, $p \leq 0.001$). In the key interview, respondents agreed that having a large number of children or a large number of family sizes will result in a growing demand for land. Therefore, agricultural land will be subdivided into smaller land holdings that may no longer be economically viable for the smallholders. Two viewpoints can be used to determine the size of the family. Primarily, a big family size means that most of the family members are able to work, which is crucial for measures to conserve soil and water. On the other hand, having fewer kids necessitates more work to create and maintain soil and water structures. The findings indicate a significant correlation between home size and water and soil conservation techniques ($\chi^2 = 36.950$, $p = 0.018$). In response to the question of gender, respondents said that because some conservation techniques demand a lot of work, male and female farmers do not equally participate in them. For instance, digging in stony terrain is highly challenging for women and requires a lot of time and energy. The findings, however, indicated that there was no

TABLE 8: Farmers' opinions and attitudes regarding contemporary water and soil conservation techniques.

Items	Response options	Frequency	Percentage
Use modern soil and water conservation	Yes	158	47.6
	No	174	52.4
	Total	332	100
Attitudes to modern soil and water conservation	Positive	276	83.1
	Negative	56	16.9
	Undecided	—	—
	Total	332	100
Reason for a positive attitude towards modern soil and water conservation	Reduce soil erosion	264	79.5
	Do not create barriers for tillage and other farming management	18	5.4
	Improved land and soil production	36	10.8
	Reduce erosion caused by water	14	4.2
	Total	332	100

connection between gender and the adoption of soil and water conservation ($\chi^2 = 14.705$, $p = 0.650$).

According to the key informant interviews ($\chi^2 = 3.541$, $p = 0.471$), large farm size negatively affects soil and water conservation practices. Moreover, farmers that have larger farm sizes are forced to expend more effort and spend more time on their farmland. This is true because, in comparison to farmers with small farms, those with larger farms can dedicate more of their land to soil and water conservation methods. An interview conducted with the Agricultural and Rural Development Office was supported as farm size became the determinant factor for soil and water conservation. Both of the above interviewers agreed that farmland is a key factor in increasing agricultural production. It is believed that as family heads' educational levels rise, there will be a greater flow of pertinent information, which will boost farmers' understanding of soil and water conservation. Education and efforts to conserve soil and water are strongly and significantly related ($\chi^2 = 23.689$, $p \leq 0.001$, $p \leq 0.001$).

Farmers are prepared to safeguard the soil, repair broken bunds, and inspect the dam when runoff occurs. The distance between the cultivation land and the homestead was influenced negatively by the techniques for soil and water conservation. The key informant interview indicated that leaving residue on the cultivation fields enhances the fertility of the soil. However, if there is agricultural land far from homes, other people will take the leftovers away for use as home fuel, animal feed, and market selling. Therefore, if the agricultural field is close to the homestead, it is simpler to handle and can receive greater care. The adoption of soil and water conservation practices and distance from the farm are strongly and significantly correlated ($\chi^2 = 35.733$, $p \leq 0.001$).

Key informant interviewers stated that farmers settled on the different slopes of land practiced different techniques for soil and water conservation. As the slope of the farm plot increases, the adoption of various conservation measures will also increase to protect the plot from severe erosion. In contrast to farmers whose farms are located on steeper slopes, which practice different types of soil and water conservation techniques since erosion is high on a steep slope, people in flat areas tend to adopt more cut-off-drain due to the erosion risk prevalent from upslope. The

conclusion was that farmers' habits of conserving soil and water are positively influenced by the slope of the area they produce. The utilization of soil and water conservation techniques is influenced by the household heads' income levels. The adoption of soil and water conservation techniques is strongly correlated with income ($p \leq 0.001$). Farmers may combat soil erosion by receiving training and raising awareness about land management methods, water conservation, and soil management. There is a considerable correlation between providing training and implementing soil and water conservation strategies ($p \leq 0.001$) (Table 9).

5. Discussion

The current study unequivocally demonstrates that there is a gender difference in the adoption of male-biased soil and water conservation technologies. In the majority of Sub-Saharan countries, women play key responsibilities in household and childcare tasks, while males decide on fieldwork tasks like using agricultural methods that increase yields like soil and water conservation. The majority of respondents were married when it came to marital status. This is consistent with Kibemo's [25] conclusion that married people frequently undertake agriculture to make ends meet and provide for their children, mostly through measures for soil and water conservation. Households with higher levels of education are more aware of the issues caused by soil erosion, are more knowledgeable about soil and water conservation, and are more likely to participate in conservation efforts. According to Fikiru [26], education enables farmers to address issues connected to soil erosion and take part in soil and water conservation activities, utilizing a variety of approaches for enhancing soil fertility. According to the data, practically all of the respondents are adults who have amassed sufficient life experience. This might also help with the adoption of methods for conserving soil and water. Due to their advanced age, the participants may have better expertise in resource management and running initiatives to save soil and water. The age of household heads has a positive impact on soil and water conservation behaviors. The majority of household heads have big families, which helps positively influence the

TABLE 9: Factors that determine techniques for soil and water conservation.

Variables	<i>F</i>	Percentage	Cumulative percent	Chi-square value (χ^2)	* <i>p</i> -value
Age	27	8.1	8.1	11.400	$p \leq 0.001^*$
Sex	16	4.8	13.0	14.705	$p = 0.650^*$
Educational status	74	22.3	35.2	23.689	$p \leq 0.001^*$
Household size	36	10.8	46.1	36.950	$p = 0.018^*$
Landholding size	38	11.4	57.5	3.541	$p = 0.471^*$
Distance from the farm	22	6.6	64.2	35.733	$p \leq 0.001^*$
Topography	53	16.0	80.1	100.454	$p \leq 0.001^*$
Income	43	13	93.1	31.905	$p \leq 0.001^*$
Continuous training	23	6.9	100.0	24.591	$p \leq 0.001^*$

Note: Gender, age, education, household size, landholding size, and distance from homestead, topography, income, and training are explanatory variables, while techniques for soil and water conservation are a dependent variable.

adoption of conservation strategies for soil and water. However, Kibemo [25] discussed the mixed effects that big family size has on soil and water conservation strategies. Thus, soil and water conservation techniques tend to have a favorable effect if the majority of the family members are able to work; otherwise, they have a negative effect. Key informants disclosed that the longer the people live in the area, the more they understand the physical and sociocultural characteristics of the area. Additionally, it was discovered through field observation that the majority of those who had been residing in the study area for a longer period of time had developed native methods for conserving soil and water, including mulching, crop rotation, manure application, traditional waterways, and stone bunds.

The finding is related to the work of Fikiru [26], on the strength of private land ownership to inspire agriculturalists towards the application of well-organized land management. The respondents concurred that owning one's own land is a good thing to practice for the conservation of one's own land with regard to the farmers' conservation practices on their land property rights. Key informant interviews have shown that more than 50% of the farmers are practicing farming activities in areas prone to erosion. It was discovered that some farm plots with a steep gradient should not have been farmed because of the pressure of human population growth. This appears to be a significant obstacle to the worsening soil erosion. They also confirmed that there is a strong correlation between the slope of the field and the level of community participation in management operations. Farmers with sloppy farmlands are less likely to practice soil and water conservation than those who live on steep slopes. A family with a large labor force is, therefore, more likely to succeed in adopting sustainable soil and water conservation measures, whereas a family with a small labor force is more likely to lag behind. This is according to the key informants, who also noted that these soil and water conservation methods require more labor.

The accumulation of household trash, animal dung, and ash on the farmland is a common practice in order to improve the soil fertility of the homestead garden in the study area. Herweg [27] described that, as a traditional soil and water conservation practice, high manure concentration is observed around the homestead area. The research region has adopted a variety of conventional and cutting-edge soil

and water conservation techniques during the last three years, according to the developmental agents. They verified that the local farmers only used conventional techniques prior to the assistance through the successful Safety Net Program. Modern strategies for conserving soil and water have been implemented in the study area in various forms. According to Tilahun [6], the best alternative new method to reduce nutrient depletion and financial loss is to use sustainable integrated land management techniques including agroforestry, organic fertilizer application, and stone-faced soil bund with vegetative measures. In the study area, soil and stone bunds were the most widely used modern soil and water conservation techniques, while Fanyajuu terraces and check dams were the least. In order to lessen the steepness of the land, a physical structure called the stone bund is built across the contour lines [28]. Modern soil and water conservation techniques were enforced by the government (a top-down strategy), while local indigenous wisdom was disregarded. Studies carried out by Kassie et al. [29] support a result that is comparable to that of the current study. They claimed that inorganic fertilizer use in Ethiopia was being constrained by issues such as rising costs, production and consumption hazards, and others. The conclusions of Lakew [30] supported the idea that improving sustainable land management might be accomplished by combining conventional soil and water conservation techniques with recently developed technologies.

Key informants suggested that a few selected breeds of animals have a great advantage as compared to other local breeds with low productivity. Furthermore, a shift towards a limited number of selected livestock breeds minimizes overgrazing, thereby reducing soil erosion. Besides, selected plant breeds are more resistant to disease, which, therefore, assists in sustainable land management. Only 3–5 percent of Ethiopia's agricultural land is covered with better-quality seeds, according to the World Bank [31], leaving a substantial number of farm households reliant on conventional types.

The age of the farmers' conservation actions may have good or negative effects, according to Bekele and Drake [32]. The findings indicated that there was no conclusive link between sexual orientation and the adoption of soil and water conservation. This suggests that the application of soil and water conservation is unaffected by gender. This is

consistent with Desalegn's work [33], who investigated the use of stone terraces for soil and water conservation in the Ethiopian highlands watershed. Farmers that have a greater education are projected to be more inclined to utilize soil and water conservation technology than illiterate ones. Habtamu [34] found that farmer decisions to keep newly installed soil and water conservation structures are positively influenced by their level of education. Furthermore, educated farmers are thought to be more aware of the risks involved with these activities and are more likely to take proper steps on their farmland.

6. Conclusion

The research region has a large number of locations that are suitable for agricultural production. Land management and methods for conserving the soil, however, are important challenges. Traditional and/or contemporary soil conservation and/or water conservation techniques have been used. Physical, vegetative, agronomic, and soil fertility management techniques are examples of conventional soil and water conservation approaches. Despite being inferior to conventional procedures, new technology is nonetheless required. However, there is little overlap between conventional and cutting-edge conservation technologies. Accordingly, a farmer's mentality might have a beneficial or negative impact on their conservation efforts. In particular, the local government must pay more attention to community mobilization for conservation measures using traditional and modern technology in order to promote soil fertility and decrease soil erosion.

Data Availability

The datasets generated and analyzed during the current study are included in the body of this paper.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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