Asian Journal of Research and Review in Agriculture

Volume 8, Issue 1, Page 55-72, 2026; Article no.AJRRA.2360

Contribution of Soil and Water Conservation Practices to Livelihood Improvement and Land Resource Restoration in Meribo and Halu Sub-Watersheds, Wondogenet Woreda, Sidama Region, Ethiopia

Wagaye Adugna [a*]

[a] *Wondo Genet Woreda Agriculture and Natural Resource Office, Wondo Genet, Ethiopia.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: https://doi.org/10.56557/ajrra/2026/v8i1195

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.globalpresshub.com/review-history/2360

Original Research Article

Received: 04/11/2025
Published: 07/03/2026

Abstract

Land degradation has long been a major environmental and socio-economic challenge in Ethiopia, particularly in Wondogenet Woreda. This study aimed to examine the contribution of soil and water conservation (SWC) practices to rural livelihoods and land resources.
A cross-sectional research design was employed using mixed (quantitative and qualitative) approaches. Data were collected from 162 household heads selected through purposive and simple random sampling. Quantitative data were analyzed using SPSS version 25 with descriptive statistics (frequency, percentage,

---

**Corresponding author: E-mail: wagayeadugna62@gmail.com;*

Cite as: *Adugna, W. (2026). Contribution of Soil and Water Conservation Practices to Livelihood Improvement and Land Resource Restoration in Meribo and Halu Sub-Watersheds, Wondogenet Woreda, Sidama Region, Ethiopia. Asian Journal of Research and Review in Agriculture, 8(1), 55–72. https://doi.org/10.56557/ajrra/2026/v8i1195*

mean, and standard deviation) and inferential statistics (independent sample t-test and binary logistic regression). Qualitative information from key informant interviews and focus group discussions was analyzed narratively for triangulation.
The results indicate that the most common physical SWC practice was Fanjuu (47.6%), while the dominant biological practices were agroforestry (45.2%) and crop rotation (40.7%). Among soil improvement measures, mulching (50%) was the most widely used. Participation in SWC practices was associated with improved livelihoods, with mean annual household income increasing from 28,096 birr (non-participants) to 32,681 birr (participants). SWC practices also enhanced land resources by improving soil fertility, increasing grass and tree cover, enhancing water availability, and reducing soil erosion and flooding. Key determinants influencing SWC adoption included labor availability, education level, land fertility, access to credit, distance to plots, training, slope category, and household income.
In conclusion, SWC practices significantly contribute to both livelihood improvement and land resource sustainability in the study area. Strengthening technical support from local institutions and promoting both physical measures (e.g., soil bunds and fanjuu) and biological practices that enhance soil organic matter are recommended to sustain and scale up the benefits.

Keywords: Soil and water conservation; livelihood improvement; land resource; socio-economic challenge.

1. Introduction

Globally, the annual loss of approximately 75 billion tonnes of soil results in an estimated economic cost of around US$400 billion per year, or roughly US$70 per person annually. Consequently, land degradation continues to represent a critical global challenge in the 21st century, given its negative impacts on agricultural productivity, environmental quality, food security, and overall quality of life. The agricultural sector plays a vital role in promoting economic development, enhancing food security, and alleviating poverty. However, the depletion of natural resources remains a major global challenge. According to the International Soil Reference and Information Centre, approximately nine million hectares of land worldwide are affected by degradation. In addition, approximately 47% of degraded land globally is forest, while cropland accounts for around 18% of the total degraded area (Bai et al., 2013; Adimassu et al., 2014; Bewket & Sterk, 2002; Bryman, 2006; Connolly, 2003). Land degradation affects an estimated two billion people and 1.9 billion hectares of land worldwide. It is further estimated that the economic cost of land degradation to the global economy ranges between USD 18–20 trillion annually (UNCCD, 2014, 1994; Haregeweyn et al., 2012; 2015; 2017; Hurni et al., 2015). Ethiopia relies heavily on agriculture to meet the demand for food and other essential goods and services. However, the sector's capacity to alleviate poverty and address food insecurity is undermined by land degradation, including soil erosion and nutrient depletion, which has consequently led to declines in both crop and livestock productivity (Akalu et al., 2016; Creswell et al., 2003; Gemechu, 2016; Haregeweyn et al., 2016). Similarly, land degradation represents a significant socio-economic and environmental challenge in Ethiopia. It is driven by factors such as inappropriate agricultural practices, steep and undulating terrain, erratic rainfall, low vegetation cover, severe water erosion, and inadequate land resource management.

Proper use of soil and water conservation practices in agriculture and forestry play an important role in global prosperity, benefiting billions of people who depend entirely on farming and forest products for their livelihood. Furthermore, soil and water conservation practices in the region are primarily aimed at managing high levels of uncertainty, reducing risk, and securing subsistence needs, rather than optimising production or maximising profits. According to Worku, (2017) that Soil and water conservation measures enhance soil texture, reduce bulk density, improve infiltration rates, increase organic matter content, and boost nutrient availability. Consequently, in the Zeiy watershed, households implementing these practices had fields with higher soil fertility compared to those that did not. This improvement in soil quality likely contributed to the higher crop yields observed among households practising soil and water conservation. In addition, Hadush (2015) reported that crop production increased to 0.673 ton ha^{-1} on smallholder farms in the Adwa district, Tigray region, following the adoption of soil and water conservation (SWC) measures. Adimassu et al. (2017) conducted a review and synthesis on the impacts of soil and water conservation (SWC) practices on crop yield, runoff, soil loss, and nutrient depletion in Ethiopia. The study demonstrated that most physical SWC measures, such as soil bunds and stone bunds, are highly effective in reducing runoff, soil erosion, and nutrient losses. Kassa et al., (2013) was studieda study titled "Impact of Integrated Soil and Water Conservation Program on Crop Production and Income in West

Hararghe Zone, Ethiopia”. Estimates using propensity score matching (PSM) indicated a significant positive impact of program participation, with an additional crop production value of Birr 1,510.42 (US$ 80.55) per hectare and an annual gross income of Birr 4,288.29 (US$ 228.70) for participating households compared to non-participants. On average, participant households earned 8.3% more in crop production value per hectare and 21.2% higher gross household income than their matched counterparts. Independent analysis further revealed that crop production value was higher in moisture-stressed program kebeles (1,771.35 Birr/ha) compared to high-rainfall areas within the program (1,439.28 Birr/ha). These findings underscore the critical role of soil and water conservation in enhancing the livelihoods of rural farm households in an agriculturally dependent country such as Ethiopia (Nyssen et al., 2010; Park, 2013; Molla& Sisheber, 2017; Temesgen et al., 2012; Tesafaye Tanto, & Fanuella Ekemiariam, 2019).

Although the Ethiopian government has promoted various soil and water conservation (SWC) practices, many farmers have been unable to implement them effectively or improve agricultural productivity. The performance of these practices has often been limited, as they are frequently carried out through campaigns without the full engagement of crop producers and livestock keepers. Farmers’ decisions to adopt agricultural technologies are influenced by a range of demographic, economic, institutional, and physical factors Yitayal& Adam, 2014; Hurni, 1993; Hurni et al., 2016; Keno & Suryabhagavan, 2014). Similarly result showed thatin Wondogenet woreda According to Kebede (2015) studied Soil erosion risk assessment in the Chaleleka wetland watershed, Central Rift Valley of EthiopiaIncreased flooding and newly formed rills and gullies were observed in the Cheleleka wetland watershed.These events weredue to problems related to land-use changes and are adversely affecting land productivity. The results indicated that only 13.6% of the study area experiences soil loss of less than 10 t ha^{-1} yr^{-1}, while the remaining area is subject to higher rates of erosion. A substantial portion, 53.6% of the Cheleleka wetland watershed, suffers from severe to extremely severe soil loss (>45 t ha^{-1} yr^{-1}), and another 17.3% of the area experiences annual soil loss of 20–45 t ha^{-1}. This demonstrates that a significant portion of the watershed in the Wondogenet area is affected by non-tolerable soil erosion, posing threats to annual crop production, land productivity, and the hydrological functioning of the region. From a conservation perspective, a large proportion of the watershed requires urgent management interventions. Despite this, research on soil and water conservation (SWC) practices among smallholders in Wondogenet Woreda remains limited, and such studies are crucial for informing policy and strategy development. Therefore, the objective of this study was to assess the contribution of SWC practices to rural livelihoods and the management of land resources in the study area (WOCAT, 2012, Mekuriaw et al., 2018).

2. Methodology

2.1 Description of the Study Area

The study area is located approximately 272 km south of Addis Ababa and 24 km east of Hawassa City in the Sidama Regional State. Geographically, it lies at 7°06′ N latitude and 38°37′ E longitude (Fig. 1). The altitude of the area ranges from 1,720 to 2,620 meters above sea level.

The climate is characterized by Woina Dega (62%) and Dega agro-climatic zones. The area receives bimodal rainfall, with the short rainy season occurring from March to May and the long rainy season from July to October. The mean annual rainfall is approximately 1,700 mm. The mean annual temperature is 28 °C, while the mean minimum temperature is 10 °C.

The major land-use types in the area include agriculture (10,106 ha), grazing land (2,484.68 ha), forest (1,333.8 ha), and residential areas (571.38 ha). The main crops produced are cereals, vegetables, fruits, cash crops, and root crops, with maize, barley, and wheat being the dominant cereals.

Regarding soils, the highland areas bordering the Rift Valley are characterised by moderately weathered, dark reddish-brown soils with a clay-loam texture (Mengistu, 2005). In contrast, soils at the lower elevations of Wondo Genet are deep, loamy, and relatively fertile Mollic Andosols. (FAO, 2015).

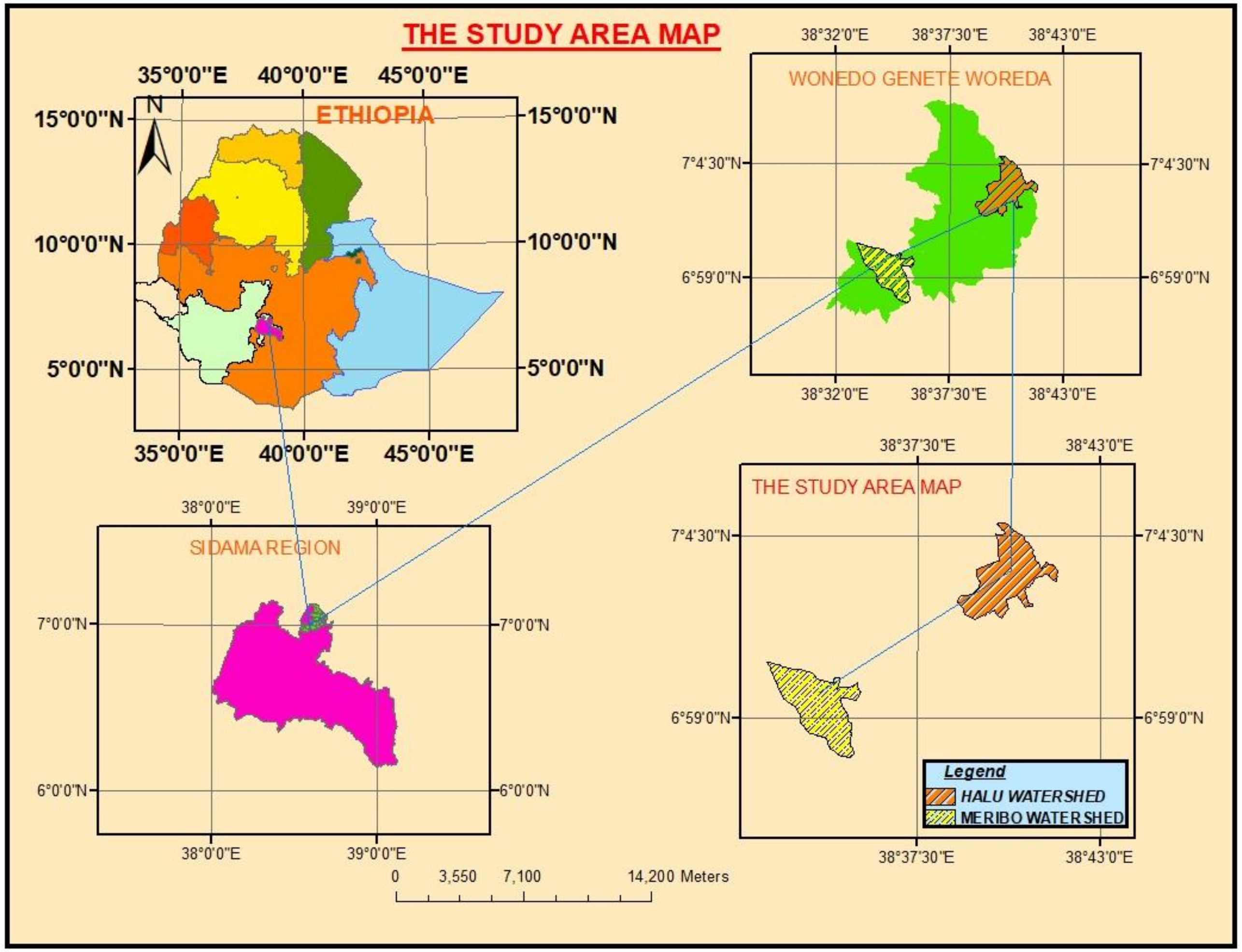

Fig. 1. Map of the study area

2.1.1 Sampling Procedures and Sample Size Determination

This study employed a cross-sectional design integrating both quantitative and qualitative research approaches. The study area was purposively selected based on accessibility in terms of transportation and communication infrastructure. Subsequently, two kebeles within the woreda were also selected purposively due to the presence of active soil and water conservation interventions.

At the final stage, household respondents were selected using simple random sampling with probability proportional to size (PPS) to ensure that households in each watershed had an equal chance of being included while reflecting their population share.

Sample Size Determination, the required sample size was determined using the rule-of-thumb formula proposed by Green (1991), which is commonly applied in regression analysis to ensure adequate statistical power:

Where: = minimum required sample size= number of explanatory (independent) variables included in the regression model50 = constant representing the base sample size 8 = multiplier representing the recommended number of observations per predictor variable In this study, the regression model included 14 explanatory variables. Therefore: Thus, the minimum required sample size was 162 households, which was adopted for the survey.

Sample Allocation, the total sample was proportionally distributed between the two study watersheds based on the number of households: Meribo watershed: 98 households Hulo watershed: 64 households. Accordingly, a total of 162 sample households were selected and included in the analysis.

2.1.2 Data Types and Method of Data Collection

To obtain comprehensive information, both quantitative and qualitative data were collected from primary and secondary sources. Secondary data were obtained from various published papers, while primary data were gathered through household surveys, supplemented by input from key informants, focus group discussions, and direct field observations.

2.1.3 Method of Data Analysis

Thedata were analyzed using both descriptive and inferential statistics. The descriptive analysis includes frequency, percentage, mean, and standard deviation were used to assess the major types of SWC activities,an independent t-test was usedto examine the contribution of soil and water conservation practices in improving the livelihood of families in the study sub-watersheds. Likewise, an independent t-test was used to analyze the contribution of soil and water conservation practices to land sources. Furthermore, binary logistic regression analysis was used to analyze determinant factors of soil and water conservation practices within the study area

2.2 Hypothesized Variables

2.2.1 Dependent Variable

The dependent variable in this study is the soil and water conservation practice of the household head. Household heads who participate in at least one of the different soil and conservation practice on their farmlandand assumed one and become a participant. Those household heads who did not participate in any of the different soil and conservation practice on their farmland and assumed zero and become non-participant.

2.2.2 Independent Variables

There is no universal rule for determining which variables should be included in a model (Anderson et al., 1994). However, the researcher relied on empirical studies to identify the variables most likely to influence the dependent variable. Accordingly, the researcher identified different demographic, social, and economic factors. The variables are Gender, Age, Family size, Labor, Education level, Land size, TLU, Land fertility, Credit, Distance, Training, Slope category, Extension service, and Income.

3. Results and Discussion

3.1 Types of SWC Activities Undertaken in the Study Area

This section presents the major soil and water conservation (SWC) activities practiced in the study watersheds. Respondents ranked the practices according to their level of participation. A weighted ranking index was calculated by multiplying each rank value (1–4) by the corresponding frequency, and the sum of scores was used to determine the relative importance of each practice.

3.1.1 Physical SWC Practices

The results in Table 1 indicate clear differences in the adoption of physical SWC measures between the two watersheds.

In Meribo watershed, Fanjuu was ranked first (rank sum = 130), with nearly half of respondents (47.6%) identifying it as their primary practice. Soil bunds followed as the second most practiced measure. Conversely, cut-off drains received the lowest ranking, indicating relatively limited adoption.

Similarly, in Halo watershed, Fanjuu also ranked first (rank sum = 79), confirming its importance across both sites. However, wooden check dams were the least preferred practice in this watershed.

These findings suggest that farmers tend to prioritize physical measures that are perceived as more effective and manageable within their local biophysical conditions, while labor-intensive or less immediately beneficial structures receive lower adoption.

3.1.2 Biological SWC Practices

As shown in Table 2, the dominant biological SWC practices varied between watersheds.

In Meribo watershed, agroforestry ranked first (rank sum = 128), indicating its strong integration into local farming systems. In contrast, crop rotation was the top-ranked practice in Halo watershed (rank sum = 76).

Key informant interviews and focus group discussions revealed that both agroforestry and crop rotation are widely recognized for improving soil fertility, enhancing moisture retention, and increasing overall farm productivity. Farmers reported maintaining diverse multipurpose tree species—such as mango, enset, moringa, and papaya—within their homesteads, which contribute to food, income, and ecological stability.

Grass strips were consistently ranked lowest in both watersheds. Participants explained that limited extension support and the perception that grass strips reduce cultivable land area discouraged their adoption.

Table 1. Physical types of soil and water conservation measures

Watershed	Physical practice	Rating Scale				Rank sum	Rank
		Rank 1	Rank 2	Rank 3	Rank 4		
Meribo watershed	Fanjuu	20 (47.6)	10 23.8)	8 (19.0)	4 (9.5)	130	1
	Soil bund	13 (31.0)	18 (42.9)	6 (14.3)	5 (11.9)	123	2
	Wooden check dam	6 (14.3)	14 (33.3)	16 (38.1)	6 (14.3)	104	3
	Cut of drain	9 (21.4)	10 23.8)	9 (21.4)	14 (33.3)	98	4
Halo watershed	Fanjuu	11 (40.7)	6 (22.2)	7 (25.9)	3 (11.1)	79	1
	Soil bund	5 (18.5)	10 (37.0)	5 (18.5)	7 (25.9)	72	2

Watershed	Physical practice	Rating Scale				Rank sum	Rank
		Rank 1	Rank 2	Rank 3	Rank 4		
	Wooden check dam	5 (18.5)	7 (25.9)	6 (22.2)	9 (33.3)	62	4
	Cut of drain	6 (22.2)	7 (25.9)	9 (33.3)	5 (18.5)	68	3

3.1.3 Soil Management Practices

The results in Table 3 highlight differences in soil management priorities between the two watersheds.

In Meribo watershed, mulching was the most widely practiced measure (50% ranked it first; rank sum = 131). This reflects the area's moisture stress conditions and the availability of crop residues, which make mulching an effective moisture-conservation strategy.

In Halo watershed, contour farming ranked first (rank sum = 82), likely due to the watershed's topography and relatively higher moisture availability, which favor erosion-control practices.

The least adopted practices differed by location: inorganic fertilizer ranked lowest in Meribo, whereas mulching was least practiced in Halo. Discussions with farmers indicated that these patterns are influenced by differences in residue availability, rainfall conditions, and local management priorities.

Table 2. Biological types of soil and water conservation measures

Watershed	Biological practice	Rating Scale				Rank sum	Rank
		Rank 1	Rank 2	Rank 3	Rank 4		
Meribo watershed	Agroforestry	19 (45.2)	11 (26.2)	7 (16.7)	5 (11.9)	128	1
	Intercropping	13 (31.0)	16 (38.1)	8 (19.0)	5 (11.9)	121	2
	Crop rotation	6 (14.3)	13 (31.0)	15 (35.7)	8 (19.0)	101	3
	Grass strip	6 (14.3)	13 (31.0)	9 (21.4)	14 (33.3)	95	4
Halo watershed	Agroforestry	5 (18.5)	10 (37.0)	7 (25.9)	5 (18.5)	69	2
	Intercropping	5 (18.5)	5 (18.5)	9 (33.3)	8 (29.6)	61	3
	Crop rotation	11 (40.7)	5 (18.5)	6 (22.2)	5 (18.5)	76	1
	Grass strip	5 (18.5)	5 (18.5)	8 (29.6)	9 (33.3)	60	4

3.2 The Contribution of SWC Practice in Improving Livelihood of Families

In this section of the study, soil and water conservation practice (SWCP) contribution in improving families' livelihood was summarized and discussed. The results are presented as follows.

Table 4. shows a significant difference between soil and water conservation participant households and non-participant households on the average annual income. The result of the independent samples *t*-test was significant (t = 7.30, p <0.01).Participant households' average income was more significant than those of non-participant households.

According toTable 4, there is a significant difference between farmers who implemented SWCP and not in their livestock holdings.. The result of the independent samples *t*-test was significant (t = 2.90, p <0.01), indicating that those who implemented SWCP have more number of TLU than their counterparts. Inconsistent with this finding, Abebe (2015) stated that the mean livestock-keeping income of adopters and non-adopters is 41121 Birr and 36803 Birr, respectively.

Table 3. Soil Management types of soil and water conservation measures

Watershed	Soil Mgt.	Rating Scale				Rank sum	Rank
		Rank 1	Rank 2	Rank 3	Rank 4		
Meribo watershed	Mulching	21 (50.0)	9 (21.4)	8 (19.0)	4 (9.5)	131	1
	Contour faming	13 (31.0)	17 (40.5)	6 (14.3)	6 (14.3)	121	2
	Organic composite	8 (19.0)	9 (21.4)	16 (38.1)	9 (21.4)	100	3
	Inorganic fertilizer	8 (19.0)	11 (26.2)	9 (21.4)	14 (33.3)	97	4
Halo watershed	Mulching	7 (25.9)	5 (18.5)	7 (25.9)	8 (19.0)	65	4
	Contour farming	12 (44.4)	7 (25.9)	5 (18.5)	3 (11.1)	82	1
	Organic composite	6 (22.2)	7 (25.9)	9 (33.3)	5 (18.5)	68	3
	Inorganic fertilizer	9 (33.3)	10 (37.0)	3 (11.1)	5 (18.5)	77	2

Table 5 showed a significant difference between soil and water conservation practice participant households and non-participant households on the average annual maize production. The result of the independent samples *t*-test was significant ($t = 6.04$, $p < 0.01$), indicating that participant households' average annual maize production was significantly greater than the average production of non-participant households. According to Ayalew (2011), similar maize yield was increased four-fold, from 40quntai-160 quintal per ha in In Southern region of Ethiopia due to participation in soil and water conservation practice in their farmland. Gatbel (2018) also indicated that the mean maize crop yield for SWC of house holds who practiced SWC was higher than those who did not practice SWC (44.74 and 23.29 quintal per hectare per household respectively). Likewise, Kifle. (2016) found that the major cereal crop productivity of SWC adopters was greater than non-adopters.

Key informants pointed out that the difference in crop productivity between participant households and non-participant households was due to the implementation of SWC practices. The group discussants also confirmed the difference in maize productivity due to SWC practices. There was also a similar significant difference in barley and wheat production between SWC participant and non-participant households (Table 5). SWC participants could be able to harvest more cereal crops than non-participants.Similar findings were observed in studies conducted in different parts of Ethiopia (Ayalew, 2011).

Table 6 showed a significant difference between soil and water conservation practice participant households and non-participant households on the average annual khat production. The result of the independent samples *t*-test was significant ($t = 12.93$, $p < 0.01$), indicating that the average khat productionsignificantly differed between the participant households (Mean = 287.41) and non-participant households (Mean = 200.78). Similarly, Mekonen and Gebreyesus (2011) found that implementing SWC measures had a positive impact on grain and biomass yield and the increment of more than 25% for grain and 30% for biomass yields**.** According to the study, *khat* is the major cash crop is grown in eastern Harereg Ethiopia and soil and water conservation. It plays a significant *role* in increasing *production* by promoting soil and water conservation practices.

The key informants indicated that khat is the most common cash crop in both Meribo and Halo watersheds. Although it is a common cash crop, SWC participant households get more khat productivity per hectarethan SWC non-participant households. As summarized inTable 6, there is no significant difference ($t = 0.45$, $p > 0.10$), between soil and water conservation practice participant households and non-participant

Table 4. The Contribution of SWC practice for income and livestock amount

Variables	SWCP				t-test	p-value
	Participant		Non-participant			
	Mean	SD	Mean	SD		
Total Income	32681.42	4850.16	28094.0	4131.60	7.30	0.000
TLU	5.63	2.48	3..61	1.99	2.90	0.004

Source: Own survey, 2024

Table 5. The contribution of SWC practice for cereal crops annual harvest in Quintal

Cereal crops	SWCP				t-test	p-value
	Participant		Non-participant			
	Mean	SD	Mean	SD		
Maize	57.85	13.97	43.11	9.28	6.04	.000
Barely	30.48	3.65	21.41	1.21	13.75	.000
Wheat	39.41	2.94	26.32	0.33	25.44	.000

Source: Own survey, 2020

Table 6. The contribution of SWC practice for cash crops annual harvest

Cash crops	SWCP				t-test	p-value
	Participant		Non-participant			
	Mean	SD	Mean	SD		
Khat	287.41	37.77	200.78	35.83	12.93	.000
Sugarcane	23.41	37.86	17.23	33.66	0.45	.654

Source: Own survey, 2020

households on the average annual sugarcane production.

According to the group's discussion result indicated that sugarcane is the least cash crop harvested in both studied areas. This is because of the long time sugarcane required to be harvested from their farmlands.

Table 7 showed a significant difference between soil and water conservation practice participant households and non-participant households on the average annual sweet potato production. The result of the independent samples *t*-test was significant ($t = 1.80$, $p < 0.10$), The key informants indicated that sweet potato is the next to maize and kahat common *Root* crops in Meribo watershed.

As it is indicated inTable 7, the same is true for potato and enset production. There were significant differences ($t = 17.27$, $p < 0.01$; $t = 10.77$, $p < 0.01$) between soil and water conservation participant and non-participant households on their average annual production of potato and enset respectively. According to group discussants, potato is a *root crop* next to barley and wheatin Halo watershed. Similar significant difference in potato and enset production was reported by Ayalew (2011) in the Southern region of Ethiopia.

Table 7. The contribution of SWC practice for root crops annual harvest

Root crops	SWCP				t-test	p-value
	Participant		Non-participant			
	Mean	SD	Mean	SD		
Sweet potato	234.90	107.36	199.59	36.82	1.80	.077
Potato	261.23	34.42	133.78	24.27	17.27	.000
Enset	331.16	56.15	188.74	49.25	10.77	.000

Source: Own survey, 2020

Table 8. The contribution of SWC practice for vegetable crops annual harvest

Vegetable crops	SWCP				t-test	p-value
	Participant		Non-participant			
	Mean	SD	Mean	SD		
Cabbage	296.58	19.73	200.99	17.49	20.03	.000
Tomato	255.91	45.61	170.32	21.25	6.96	.000
Avocado	243.45	29.77	145.36	45.90	12.07	.000
Mango	307.69	76.55	181.43	83.01	7.53	.000

Source: Own survey, 2020

There were significant differences ($P < 0.01$) between soil and water conservation practice participant and non-participant households on their average annual production of cabbage, tomato, avocado and mango (Table 8). The focus group's discussion reported that soil and water conservation users adopted improved seeds, organic and inorganic fertilizers mulching on their farmlands which resulted in improved productivity of cabbage, tomato, avocado, and mango per hectare.

The key informants also indicated that the presence of perennial crops such as avocado and other biological conservation measures like grass strips in their farms protect fields from both water and wind erosion and hold soil nutrients in place which is beneficial for avocado production.

In general, Yitayal & Adam, (2014) stated that investments in soil and water conservation (SWC) practices enhance crop production, food security, and household income. Soil and water conservation practices have the potential to boost crop productivity.

3.3 The Contribution of SWCP to Land Resources

In this section, the contribution of soil and water conservation practice (SWCP) to land resources was summarized and discussed. The results are presented as Table 9.

In line with land fertility,As it is indicated in Table 9,the majority of sampled respondents (54.3%) agreed thatsoil and water conservation practice increases land fertility.The key informants indicated that even though most of the respondents in the studied watersheds believe that there is a lot to be gained from the soil and water conservation practices few respondents in the studied watershed's believed that soil and water conservation practice decreases land fertility. Their misunderstanding comes from the inability of farmers to get assistance from agricultural development agents. They live far from the center and have no real information about soil and water conservation practices. Similarly, studies (Mekuria et al., 2018; Damene et al., 2013; Descheemaeker et al. 2009) reported that soil and water conservation practices had a high contribution in restoring soil fertility by increasing organic matter of soil, the holding capacity of water, and nutrient availability in the soil.

Regarding grass supply,as presented in table 9,58% offarmersanswered thatsoil and water conservation practice increases grass supply,whereas6.8% of themindicated thatsoil and water conservation practice decreases grass supply. The focus group's discuss ants reported that some of the landsareprotected from animal and human intervention, they could produce more grasses which enable farmers to use it as fodder for their livestock. Inconsistent with this finding, (Mekuria et al., 2007; Mengistu et al. 2005) indicated that SWC practices highly contribute to the increment of grass supply.

The majority of sampled respondents (58.6%) argued that SWC practice increases the number of trees (Table 9). The key informants indicated that fuelwood is one of the critical problems in the studied watersheds. Adopters of soil and water conservation practice usually use planting trees for multi-purposes. They plant cord Africana, mango, avocado trees grown on their private plots of land. In line with this finding, Mengistu et al. 2005; Mekuria, 2007) reported the contribution of SWC in increasing vegetation cover and biodiversity.

Table 9. The contribution of soil and water conservation practices to land sources

No.	Variables	HD		D		NC		I		HI	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%
1	Land fertility	0	0.0	9	5.6	53	32.7	88	54.3	12	7.4
2	Grass supply	3	1.9	8	4.9	57	35.2	77	47.5	17	10.5
3	Number of trees	4	2.5	6	3.7	57	35.2	77	47.5	18	11.1
4	Water supply	4	2.5	6	3.7	55	34.0	77	47.5	20	12.3
5	Soil erosion	29	17.9	73	45.1	57	35.2	3	1.9	0	0.0
6	Flooding	31	19.1	75	46.3	53	32.7	3	1.9	0	0.0
7	Availability of forage	3	1.9	4	2.5	51	31.5	80	49.4	24	14.8

Note: HD=Highly decreased, D=Decreased, NC=No change, I=Increased, and HI=Highly increased
Source: Own survey, 2020

The majority of respondents (63 and 65.4 %) explained that erosion and flood hazards were decreased respectively as a result of SWC practices. Similarly,the majority (64.2 and 59.8%) of respondents reported that the availability of forage and water was improved respectively as a resultof theirSWC practices (Table 9). The key informants explained that soil and water conservation practice helps to protect the removal of fertile topsoil in the farmland and percolate the rainwater percolate down which resulted in the availability of water and forage in the watersheds. In corresponding to this finding, Anwar et al. (2016) stated that contribution of soil and water conservation practices to increasing groundwater recharge.

As Fig. 2 presents, sampled respondents were asked whether the implementation of SWCP brings change to their land resources or not. Accordingly, 63% of respondents indicated that the implementation of SWCP brings change to their land resources. In contrarily, 37% of farmers were not benefited from the implementation of SWCP. The result implies that the majority of farmers in the study area were benefited from the implementation of SWCP. The key informants also added that soil and water conservation practice helps ‘increasing vegetation cover and biodiversity, enhancing ecosystem carbon stocks, reducing soil erosion, restoring soil fertility, increasing groundwater recharge.

3.4 Determinant Factors of Soil and Water Conservation Practices

The chi-square result ($\chi^2 = 114.18$, $p < 0.001$) indicates that the logistic regression model is statistically significant. This shows that the independent variables included in the model—gender, family size, labor force, education level, land size, tropical livestock unit (TLU), land fertility, credit access, distance to plot, training, slope category, extension service, and income—jointly explain variations in the adoption of soil and water conservation (SWC) practices. The significant variables are discussed below.

3.4.1 Labor Force

Labor force was statistically significant at the 5% probability level and showed a positive association with SWC practice. The positive regression coefficient indicates that households with a higher proportion of productive-age members (15–65 years) are more likely to adopt SWC practices. Specifically, holding other variables constant, an increase of one unit in labor force increases the odds of adopting SWC practices by a factor of 1.584.

This suggests that households with more active agricultural workers are better able to invest in labor-intensive conservation measures. Similar findings were reported by Kifle et al. (2016), who found a positive relationship between labor availability and SWC adoption. Likewise, Akalu et al. (2016) showed that farm labor availability significantly influences both initial and final adoption stages of SWC practices. Tesfaye & Ayalew, (2017) also noted that larger household labor capacity enhances farmers’ decisions to implement sustainable land management (SLM) practices.

3.4.2 Educational Level

Educational level has a positive and statistically significant effect on SWC adoption at the 5% level. The odds ratio indicates that an increase of one unit in education raises the likelihood of adopting SWC practices by a factor of 2.366.

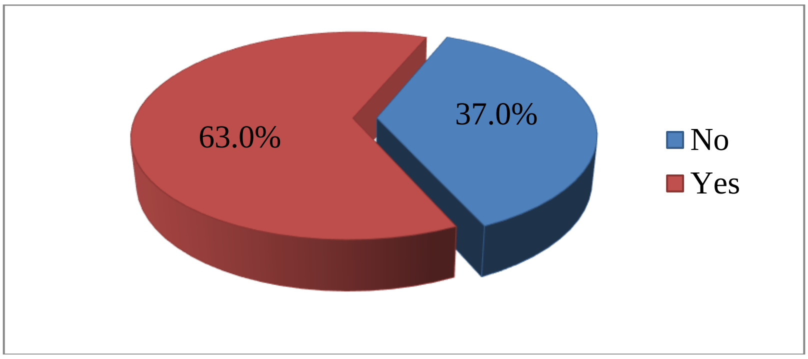

Fig. 2. Change in the implementation of SWCP to land resource
Source: Own survey, 2020

Table 10. Results of binary logistic regression model

Variables	B	S.E	Wald	p-Value	Exp(β)
Gender	-.018	.856	.000	.983	.982
Age	-.016	.025	.414	.520	.984
Family size	-.144	.263	.302	.583	.866
Labor	.460	.207	4.912	.027	1.584
Education level	.861	.391	4.848	.028	2.366
Land size	2.663	1.823	2.133	.144	14.339
Tropical livestock units	.091	.115	.632	.427	1.096
Land fertility	-.878	.485	3.280	.070	.416
Credit	1.200	.628	3.652	.056	3.319
Distance	-.054	.031	2.976	.085	.948
Training	1.544	.603	6.559	.010	4.684
Slope category	1.146	.447	6.569	.010	3.146
Extension service	1.048	.767	1.866	.172	2.853
Income	.173	.069	6.292	.012	1.189
Constant	-13.105	3.618	13.117	.000	.000
Chi-Square	114.18				
p-value	0.000				
Pseudo R^2	0.679				

Note: β= Binary logit coefficient (Estimate), SE=Standard Error
Source: Computed from own survey, 2020

This implies that educated farmers are more likely to understand soil erosion problems and adopt appropriate conservation measures. Gatbel (2018) similarly found that education enhances awareness of erosion risks and mitigation strategies. Feyissa, (2014) and Tizazu (2017) also confirmed that education significantly improves the adoption of SWC practices by enhancing farmers' ability to access information and interact with extension services.

3.4.3 Land Fertility

Land fertility shows a significant relationship with SWC adoption. Households with highly fertile land tend to participate less in SWC practices, whereas those with less fertile land are more actively involved. This may be because farmers with fertile plots perceive lower immediate risk from land degradation. Amsalu and de Graaff (2006) reported a similar negative association between high land fertility and SWC adoption.

3.4.4 Credit Facility

Access to credit has a positive and significant effect on SWC practice. The regression coefficient indicates that households with credit access are more likely to adopt conservation practices, as credit enables investment in inputs such as organic fertilizers and improved seeds. This finding is consistent with Alufah et al. (2012), and Boureima et al. (2018), who all reported that credit availability significantly enhances adoption of SWC technologies.

3.4.5 Distance to Plot

Distance from the homestead to farmland has a negative and statistically significant effect on SWC adoption. The odds ratio (0.948) indicates that as distance increases by one unit, the likelihood of adopting SWC practices decreases. This suggests that farmers are less likely to invest in conservation measures on distant plots due to reduced supervision and higher labor costs. Similar results were reported by Abdul-Hanan (2017).

3.4.6 Training

Training was highly significant ($p < 0.001$) and positively influenced SWC adoption. Households that received training were more likely to implement conservation practices, as training enhances awareness, skills, and confidence in using new technologies. Akalu et al. (2016), similarly found that training programs play a crucial role in promoting adoption of SWC measures.

3.4.7 Slope Category

Slope category has a positive and significant effect on SWC adoption. Farmers cultivating steep slopes are more likely to implement conservation measures because erosion risks are more visible and severe. This finding agrees with Tizazu (2017), who reported that steeper land increases the likelihood of adopting SWC practices.

3.4.8 Income

Household income positively and significantly affects SWC adoption at the 5% level. As income increases, farmers are better able to finance conservation activities and purchase necessary inputs, thereby increasing adoption likelihood. Kifle, (2016) also emphasized that higher income improves farmers' capacity to invest in land management technologies.

4. Discussion

In the study area, the primary physical soil and water conservation practice identified was the Fanjuu structure. Key informants highlighted that leveledFanjuu bunds are particularly effective for controlling surface runoff, preventing nutrient loss, improving soil quality, and enhancing crop production. This observation is supported by focus group discussions, which suggested that the average land slope of 20-30% in the study watersheds is well-suited for the construction of Fanjuu bunds. This finding aligns with Damene et al. (2013), who noted that Fanjuu bunds were the most commonly used soil and water conservation practice among participants in the West Harerghe Zone, Ethiopia, with 71% adoption. Similarly, Teshome et al. (2014) observed that farmers prioritized Fanjuu bunds for erosion control on moderate slopes in North-Western Ethiopia. Yitayal and Adam (2014) also reported that Fanjuu bunds were the most widely adopted practice in Adama District, Ethiopia, followed by soil bunds in terms of adoption intensity.Soil bunds, while less commonly adopted than Fanjuu bunds, were still significant in minimizing labor for SWC establishment. However, practices such as cut-off drains and wooden check dams were less favored due to their high cost, labor requirements, and the significant land area they occupy. Alemayehu (2019) corroborates this, indicating that cut-off drains (13.7%) and wooden check dams (17.3%) were among the least adopted practices in Ensaroworeda, Amhara region. Conversely, Ali, (2013) found that cut-off drains were a dominant SWC practice in the Tigray Region, likely due to their effectiveness in managing excess runoff from uplands. Agroforestry emerged as a prominent SWC practice in the Lante, Arba Minch area, as noted by Mekonnen (2016). Mersha (2017) further emphasized that agroforestry home gardens are highly valued for their ecosystem services and role in smallholder livelihoods in southern Ethiopia. Sileshi (2016) highlighted that Gedeo agroforestry is a principal livelihood system that integrates various crop types, including staple, cash, and supplementary crops, rather than merely supplementing staple crops.

Crop rotation was ranked as the most important SWC practice in EnsaroWoreda and was more widely adopted than other biological SWC practices in the Bale Eco Region. Intercropping, while also significant, was the second most practiced SWC method in Lante, Arba Minch (Guadie et al., 2020), and served multiple functions such as maintaining soil organic matter, reducing soil evaporation, and providing shade. The use of grass strips as an SWC practice was minimal in the study area, with Alemayehu (2019) reporting only 6.6% adoption in EnsaroWoreda and Chowdhury et al. (2016) noting their limited use overall. Mulching and contour plowing were highlighted as important soil management techniques in Bale. Additionally, inorganic fertilizer application was more prevalent in the Halo watershed compared to the Meribo watershed, likely due to the steep terrain of the former. This finding is consistent with the study of Chowdhury et al. (2016) in the Bale highlands. In contrast, Chany (2018) found that inorganic fertilizer use was minimal in the Zeiy watersheds, Majang Zone Gambella, due to less degraded land conditions.

5. Contribution of SWC Practices to Livelihood Improvement

Studies indicate that households engaged in SWC practices generally have higher incomes compared to those who do not. Gatbel et al. (2019) reported that households practicing SWC earned more than their non-practicing counterparts. Similarly, Kassa et al., (2013) found increased gross annual incomes among SWC adopters in West Hareghe, Oromia Region. Previous studies also observed higher average household incomes among SWC practitioners in the Adwa district, Tigray Region.

6. Conclusion

The main purpose of this study was to examine the contribution of soil and water conservation (SWC) practices to rural livelihoods and land resources in the Meribo and Halo sub-watersheds of the Wondo Genet area, Sidama Regional State, Ethiopia. The study was guided by specific research questions derived from the overall objectives presented in Chapter One.

Chapter Two reviewed relevant theoretical and empirical literature on the role of SWC practices in improving livelihoods and sustaining land resources. Chapter Three described the research methodology. A cross-sectional survey design was employed to collect quantitative data from households, complemented by interview guidelines to support and triangulate the survey results. Both purposive and simple random sampling techniques were used to select study units. A total of 162 households participated in the survey, including 69 SWC participant households and 93 non-participant households, resulting in a 100% response rate.

Data were analyzed using descriptive and inferential statistical techniques. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used to summarize socio-economic and demographic characteristics. Weighted scores were applied to identify dominant SWC activities. Independent samples t-tests were used to compare livelihood outcomes between participant and non-participant households. Percentile analysis assessed the contribution of SWC practices to land resources, while binary logistic regression identified determinant factors influencing adoption of SWC practices.

The findings indicated that Fanjuu was the dominant physical SWC practice, while agroforestry and crop rotation were the major biological measures, and mulching was the principal soil management practice. The t-test results revealed that SWC practices significantly improved household livelihoods, as participant households had higher average income, greater livestock holdings, and higher crop production compared to non-participants.

Regarding land resources, SWC practices contributed to improved soil fertility, increased grass and forage availability, enhanced tree cover, improved water availability, and reduced soil erosion and flooding. The conservation structures helped reduce runoff, enhance water infiltration, and protect fertile topsoil.

The logistic regression results showed that labor force availability, education level, access to credit, training, slope category, and household income positively influenced the adoption of SWC practices. In contrast, land fertility and distance from farmland negatively affected adoption.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Competing Interests

Author has declared that no competing interests exist.

References

Abdul-Hanan, A. (2017). Determinants of adoption of soil and water and conservation techniques: evidence from Northern Ghana. *International Journal of Sustainable Agricultural Management and Informatics, 3*(1), 31-43. https://doi.org/10.1504/IJSAMI.2017.082918

Abebe, G. (2015). Contribution of soil and water conservation practices towards sustainable rural livelihoods in the Tigray region, Northern Ethiopia (Master's thesis). Mekelle University.

Adimassu, Z., Langan, S., & Johnston, R. (2017). Impacts of soil and water conservation practices on crop yield, run-off, soil loss and nutrient loss in Ethiopia: Review and synthesis. *Environmental Management, 59*, 87–101. https://doi.org/10.1007/s00267-016-0776-1

Adimassu, Z., Mekonnen, K., Yirga, C., & Kessler, A. (2014). Effect of soil bunds on run-off, soil and nutrient losses, and crop yield in the central highlands of Ethiopia. *Land Degradation & Development*, *25*(6), 554–564. https://doi.org/10.1002/ldr.2182

Ali, M. (2013). Status of soil and water conservation practices in Tigray Region, Ethiopia: A case study. *International Journal of Advanced and Innovative Research, 2*(4).

Akalu, T., de Graaff, J., & Kassie, M. (2016). Household-level determinants of soil and water conservation adoption phases: Evidence from north-western Ethiopian highlands. Environmental Management, 57, 620–636. https://doi.org/10.1007/s00267-015-0635-5

Alemayehu, G. (2019). *Contribution of soil and water conservation practices to livelihoods and food security in Ensaro Woreda, Amhara National Regional State* (Unpublished master's thesis). Addis Ababa University, Ethiopia.

Alufah, S., Shisanya, C., & Obando, J. (2012). Analysis of factors influencing adoption of soil and water conservation technologies in Ngaciuma sub-catchment, Kenya. *African Journal of Basic and Applied Science, 4*(5), 172–185. https://doi.org/10.5829/idosi.ajbas.2012.4.5.1112

Amsalu, A., & de Graaff, J. (2006). Farmers' views of soil erosion problems and their conservation knowledge at Beressa watershed, central highlands of Ethiopia. Agriculture and Human Values, 23(1), 99-108. https://doi.org/10.1007/s10460-005-5872-4

Anderson, J. R., & Thampapillai, D. J. (1994). A review of the socio-economic analysis of soil degradation problems for developed and developing countries. Review of Marketing and Agricultural Economics, 62(3), 291-315. https://doi.org/10.22004/ag.econ.12318

Anwar, A. A., Aynalem, D. W., Tilahun, S. A., Mekuria, W., Azeze, M., & Steenhuis, T. S. (2016). Effectiveness of land and water management interventions in reducing runoff and soil erosion in the northwestern highlands of Ethiopia [Abstract]. Paper presented at the First African Ecosystem Services Partnership (ESP) Conference, Nairobi, Kenya, November 21–25, 2016. https://api.semanticscholar.org/CorpusID:134791220

Ayalew, B. (2011). Soil and water conservation practices on crop productivity and its economic implications in Ethiopia. *Asian Journal of Agricultural Research, 11*(4), 128–136. https://doi.org/10.3923/ajar.2017.128.136

Bai, Z. G., Dent, D. L., Olsson, L., & Schaepman, M. E. (2008a). Proxy global assessment of land degradation. *Soil Use and Management, 24*(3), 223–234. https://doi.org/10.1111/j.1475-2743.2008.00169.x

Bewket, W., & Sterk, G. (2002). Farmers' participation in soil and water conservation activities in the Chemoga watershed, Blue Nile basin, Ethiopia. *Land Degradation & Development, 13*, 189–200. https://doi.org/10.1002/ldr.492

Boureima, Y. K., Zhanqi, W., Yamba, B., & Chao, W. (2018). Factors influencing farmers' adoption of soil and water control technology (SWCT) in Keita Valley, a semi-arid area of Niger. *Sustainability, 10*, 288. https://doi.org/10.3390/su10020288

Bryman, A. (2006). *SAGE benchmarks in social research methods: Mixed method* (Vol. 1, 1st ed.). Los Angeles, CA: SAGE Publications Ltd. https://us.sagepub.com/en-us/nam/mixed-methods/book226000

Connolly, P. (2003). *Ethical principles for researching vulnerable groups: A guideline*. Ulster: University of Ulster. https://www.cain.ulst.ac.uk/issues/victims/docs/connolly03.pdf

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), Handbook of mixed methods in social and behavioral research (pp. 209–240). Sage. https://doi.org/10.4135/9781412986282.n10

Chowdhury, P., Ray, S. K., Namei, A., & Bidyut, C. D. (2016). Soil and water conservation measures through low-cost scientific methods. *Conservation of Natural Resources and its Efficient Utilization for Sustaining Hill Agriculture*, 28-33.

Damene, S., Tamene, L., & Vlek, P. L. G. (2013). Performance of exclosure in restoring soil fertility: A case of Gubalafto district in North Wello Zone, northern highlands of Ethiopia. *Catena, 101*, 136–142. https://doi.org/10.1016/j.catena.2012.10.010

Descheemaeker, K., Muys, B., Nyssen, J., Sauwens, W., Haile, M., Poesen, J., Raes, D., & Deckers, J. (2009). Humus form development during forest restoration in exclosures of the Tigray highlands, Northern Ethiopia. *Restoration Ecology, 17*(2), 280–289. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1526-100X.2007.00346.x

FAO. (2015). *Status of the world's soil resources (SWSR) – Technical summary*. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils. Rome, Italy. https://www.fao.org/3/i4976en/i4976en.pdf

Feyissa, T. (2014). Adoption of soil and water conservation measures in kundudo mountain catchment, Jarso district, East Hararghe zone, Oromia National Regional State. Unpublished work style), unpublished.

Gatbel Chot Chany. (2018). *Assessment of the impact of soil and water conservation practices on farmers' livelihood in Zeiy watershed, Manjag zone, Gambella region, Ethiopia* (Unpublished master's thesis). Arba Minch University, Ethiopia. https://doi.org/10.5897/AJEST2018.2643

Gatbel Chot, Moges, A., & Shewa, A. (2019). Impacts of soil and water conservation practices on livelihood: The case of a watershed in Gambela region, Ethiopia. *African Journal of Environmental Science and Technology*. https://academicjournals.org/journal/AJEST/article-full-text/96371DE60872

Gemechu, A. A. (2016). Estimation of soil loss using the revised universal soil loss equation and determinants of soil loss in Tiro Afeta and Dedo districts of Jimma Zone, Oromiya National Regional State, Ethiopia. *Trends in Agricultural Economics, 9*(1–3), 112. https://doi.org/10.3923/tae.2016.1.12

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research, 26*(3), 499–510. https://doi.org/10.1207/s15327906mbr2603_7

Guadie, M., Molla, E., Mekonnen, M., & Cerdà, A. (2020). Effects of Soil Bund and Stone-Faced Soil Bund on Soil Physicochemical Properties and Crop Yield Under Rain-Fed Conditions of Northwest Ethiopia. **Land*, *9*(1),* 13. https://doi.org/10.3390/land9010013

Hadush, M. (2015). The role of community-based watershed management for rural livelihood in Wereda Adwa, Central Tigray Zone. *International Journal of Weather, Climate Change and Conservation Research, 2*(1), 22–46.

Haregeweyn, N., Berhe, A., Tsunekawa, A., Tsubo, M., & Meshesha, D. T. (2012). Integrated watershed management as an effective approach to curb land degradation: A case study of the Enabered watershed in northern Ethiopia. Environmental Management, 50(6), 1219–1233. https://doi.org/10.1007/s00267-012-9952-0

Haregeweyn, N., Tsunekawa, A., Nyssen, J., Poesen, J., Tsubo, M., Meshesha, D. T., Schutt, B., Adgo, E., & Tegegne, F. (2015). Soil erosion and conservation in Ethiopia: A review. *Progress in Physical Geography, 39*(6), 750–774. https://doi.org/10.1177/0309133315598725

Haregeweyn, N., Tsunekawa, A., Poesen, J., Tsubo, M., Meshesha, D. T., Fenta, A. A., Nyssen, J., & Adgo, E. (2017). Comprehensive assessment of soil erosion risk for better land use planning in river basins: A case study of Upper Blue Nile River. *Science of the Total Environment, 574*, 95–108. https://doi.org/10.1016/j.scitotenv.2016.09.019

Haregeweyn, N., Tsunekawa, A., Tsubo, M., Meshesha, D., Adgo, E., Poesen, J., & Schutt, B. (2016). Analyzing the hydrologic effects of region-wide land and water development interventions: A case study of Upper Blue Nile Basin. *Regional Environmental Change, 16*(4), 951–966. https://doi.org/10.1007/s10113-015-0813-2

Hurni, H. (1993). Land degradation, famine and resources scenarios in Ethiopia. In D. Pimental (Ed.), *World soil erosion and conservation* (pp. 27–44). Cambridge University Press. https://doi.org/10.1017/CBO9780511735394.004

Hurni, H., Debele, B., & Zeleke, G. (2015). Saving Ethiopia's soils. In A. Ehrensperger, C. Ott, & U. Wiesmann (Eds.), *Eastern and Southern Africa Partnership Programme: Highlights from 15 years of joint action for sustainable development* (pp. 27–30). Centre for Development and Environment, University of Bern with Bern Open Publishing. https://doi.org/10.7892/boris.72023

Hurni, W. A., Berhe, P., & Chadhokar, A. (2016). Soil and water conservation in Ethiopia.

Kassa, Y., Beyene, F., Haji, J., & Legesse, B. (2013). Impact of integrated soil and water conservation program on crop production and income in West Harerghe Zone, Ethiopia. *International Journal of Environmental Monitoring and Analysis, 1*(4), 111-120.

Kebede, W. (2015). Soil erosion risk assessment in the Chaleleka wetland watershed, Central Rift Valley of Ethiopia. https://doi.org/10.1186/s40068-015-0030-5

Keno, K., & Suryabhagavan, K. V. (2014). Multi-temporal remote sensing of landscape dynamics and pattern change in Dire district, Southern Ethiopia. *Journal of Geomatics, 8*(2), 189–194. https://doi.org/10.4172/2157-7617.1000226

Kifle, S., Teferi, B., Kebedom, A., & Legesse, A. (2016). Factors Influencing Farmers Decision on the Use of Introduced Soil and Water Conservation Practices in the Lowland's of Wenago Woreda, Gedeo Zone, Ethiopia. American Journal of Rural Development, 4(1), 24–30. https://doi.org/10.12691/ajrd-4-1-4

Kifle, T. (2016). Land Management Practices and Their Contribution to Livelihoods and Land Resources Conservation in Bale Eco-Region, South Eastern Ethiopia.

Mekonen, K., & G.B. (2011). Impact assessment of soil and water conservation measures at Medego watershed in Tigray, northern Ethiopia. *Maejo International Journal of Science and Technology, 5*(3), 312–330. https://www.mijst.mju.ac.th/

Mekonnen Alemu, M. (2016). Indigenous Agroforestry Practices in Southern Ethiopia: The Case of Lante, Arba Minch. Open Access Library Journal, 3(12), 1–12. https://doi.org/10.4236/oalib.1103278

Mekuria, W. (2007). Effectiveness of exclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. *Journal of Arid Environments, 69*, 270–284. https://doi.org/10.1016/j.jaridenv.2006.10.009

Mekuria, W., Veldkamp, E., Haile, M., et al. (2007). Effectiveness of exclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. *Journal of Arid Environments, 69*, 270–284. https://doi.org/10.1016/j.jaridenv.2006.10.009

Mekuriaw, A. (2017). Assessing the effectiveness of land resource management practices on erosion and vegetative cover using GIS and remote sensing techniques in the Melaka watershed, Ethiopia. *Environmental Systems Research, 6*, 16. https://doi.org/10.1186/s40068-017-0093-6

Mekuriaw, A., Heinimann, A., Zeleke, G., & Hurni, H. (2018). Factors influencing the adoption of physical soil and water conservation practices in the Ethiopian highlands. *International Soil and Water Conservation Research, 6*, 23–30. https://doi.org/10.1016/j.iswcr.2017.12.006

Mengistu, T., Teketay, D., Hulten, H., & Yemshaw, Y. (2005). The role of enclosures in the recovery of woody vegetation in degraded dryland hillsides of central and northern Ethiopia. *Journal of Arid Environments, 60*(2), 259–281. https://doi.org/10.1016/j.jaridenv.2004.03.014

Mersha, G. (2017). *Agroforestry home gardens in Ethiopia: Rural livelihoods in transition*. https://pub.epsilon.slu.se/14300/1/mersha_g_170531.pdf

Molla, T., & Sisheber, B. (2017). Estimating soil erosion risk and evaluating erosion control measures for soil and water conservation planning at Koga watershed in the highlands of Ethiopia. *Solid Earth, 8*, 13–25. https://doi.org/10.5194/se-8-13-2017

Nyssen, J., Clymans, W., Descheemaeker, K., Poesen, J., Vandecasteele, I., Vanmaercke, M., Zenebe, A., Van Camp, M., Haile, M., Haregeweyn, N., Moeyersons, J., Martens, K., Gebreyohannes, T., Deckers, J., & Walraevens, K. (2010). Impact of soil and water conservation measures on catchment hydrological response—a case in North Ethiopia. *Hydrological Processes, 24*(13), 1880–1895. https://doi.org/10.1002/hyp.7628

Park, H. (2013). An introduction to logistic regression: From basic concept to interpretation with particular attention to nursing domain. *Journal of Korean Academy of Nursing, 43*(2), 154– 164. https://doi.org/10.4040/jkan.2013.43.2.154

Sileshi, D. (2016). *Home garden agroforestry practices in the Gedeo zone, Ethiopia: A sustainable land management system for the socio-ecological benefit*. https://collections.unu.edu/eserv/UNU:5769/SEPLS_in_Africa_FINAL_lowres_web.pdf

Temesgen, M., Uhlenbrook, S., Simane, B., Vander Zaag, P., Mohamed, Y., Wenninger, J., & Savenije, H. H. G. (2012). Impacts of conservation tillage on the hydrological and agronomic performance of Fanyajuus in the Upper Blue Nile (Abbay) river basin. *Hydrology and Earth System Sciences*, *16*, 4725–4735. https://doi.org/10.5194/hess-16-4725-2012

Tesafaye, T., & Fanuella, E. (2019). Impacts of soil and water conservation practices on soil property and wheat productivity in Southern Ethiopia. *Environmental Systems Research*, *8*, Article 13. https://doi.org/10.1186/s40068-019-0142-4

Tesfaye, A., & Ayalew, B. B. (2017). Effective Safety Management in Construction Project. IOP Conference Series: Materials Science and Engineering. https://doi.org/10.1088/1757-899X/291/1/012018

Teshome, A., de Graaff, J., & Stroosnijder, L. (2014). Evaluation of soil and water conservation practices in the north-western Ethiopian highlands using multi-criteria analysis. Frontiers in Environmental Science, 2, 60. https://doi.org/10.3389/fenvs.2014.00060

Tizazu Toma, D. (2017). Determinants of adoption of soil and water conservation practices at household level in Aletawendo District, Sidama Zone, SNNPR, Ethiopia. *World Journal of International Research*. https://www.academia.edu/download/59184934/WJIR030401220190509-29933-1x5egaf.pdf

UNCCD. (1994). *Elaboration of an international convention to combat desertification in countries experiencing serious drought and/or desertification, particularly in Africa: Final text of the convention*. https://digitallibrary.un.org/record/194000?ln=en

UNCCD. (2014). Land-based adaptation and resilience: Powered by nature. https://www.elninitiative.org/fileadmin/pdf/Land_Based_Adaptation_ENG_S.pdf

WOCAT. (2012). *Desire for greener land options for sustainable land management in drylands*. World Overview of Conservation Approaches and Technologies. https://www.wocat.net/fileadmin/user_upload/documents/Books/DESIRE_BOOK_low_resolution.pdf

Worku, H. (2017). Impact of physical soil and water conservation structure on selected soil physicochemical properties in Gondar Zuriya Woreda. *Resources and Environment*, *7*(2), 40-48

Yitayal, A., & Adam, B. (2014). The impact of soil and water conservation program on the income and productivity of farm households in Adama District, Ethiopia. *Science, Technology and Arts Research Journal*, *3*(3), 198–203.
https://doi.org/10.4314/star.v3i3.32

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.globalpresshub.com/review-history/2360