



Effective Soil and water Conservation Measures for Environmental Sustainability in Ethiopia: A Review Study

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Abstract

Soil productivity in Ethiopia has been declining due to multiple forms of land degradation, including water erosion, soil acidity, salinization, nutrient depletion, and deterioration of soil physical properties. Among these, soil erosion is the most severe ecological challenge, significantly threatening agricultural productivity and national food security. The review study examines effective soil and water conservation (SWC) measures implemented in Ethiopia and their role in promoting environmental sustainability. The review indicates that SWC practices are essential for reducing soil fertility degradation, conserving soil moisture, and improving water-use efficiency, thereby enhancing crop yields, particularly in environmentally vulnerable areas. Empirical evidence from various regions of the country shows that physical conservation structures, especially soil bunds, significantly reduce surface runoff and soil loss, although their effectiveness varies depending on site-specific conditions. Since the mid-1970s, considerable efforts have been made to promote SWC through government initiatives and the involvement of non-governmental organizations. However, the success of these interventions remains constrained by challenges such as land tenure insecurity, limited access to appropriate technologies, financial limitations, inadequate technical support, and low levels of community participation. In addition, many SWC initiatives lack integrated participatory approaches. Overall, the reviewed studies demonstrate that effective and context-specific execution of SWC measures significantly increases soil quality and contributes to long-term environmental sustainability in Ethiopia.

Keywords: Approaches, Characteristics, Extensive efforts, Runoff, Soil loss.

1. Introduction

Agriculture forms the biggest component and bedrock of Ethiopia's economic development, contributing to about 32.7% share of the country's GDP and 65.62% of employment (NBE, 2020). With 80% of Ethiopia's 105 million people living in rural areas (FAOSTAT, 2018), the agriculture sector primarily consists of smallholder farmers who make their living from less than two hectares of land. More than 85% of the Ethiopian population, which resides in the rural area, is engaged in agricultural production as a major means of livelihood (World Bank 2006, FAO (with Schweiz). (2011). However, production from agriculture is severely limited by irregular rainfall patterns, inadequate soil fertility, and land degradation. Soil erosion is especially hazardous, with areas losing more than 100 tons per hectare annually and annual soil losses estimated to exceed 1-1.5 billion (K. Hurni, 2015). In addition to decreasing soil depth and nutrient availability, losses that result contribute to the sedimentation of rivers, dams, and irrigation systems.

For the availability of needs including food, fuel, and income, living standard or livelihood safety in Ethiopia, mainly in the uplands, relies extensively on homegrown resources (Sharma, 2018), especially the associated with environment, soil and water (Field et al., (2018)). In rural areas where agriculture is the primary source of livelihoods, it is particularly high (Malmberg et al., 2018). In Ethiopia's rain fed agricultural landscapes, soil destruction is the fundamental source of land deprivation. Concerning toward delivering many additional environmental benefits, it is the highest destructive environmental development reflected in the country. It destroys the valuable soil sources that are the foundation of farming, agricultural output and food for the nation's community. Soil and water conservation developed a matter of societies existence as soil productivity declined because of increased erosion (Hunri et al., 2015.)

Ethiopia's annual soil deterioration of 1.5-2 billion tons is mostly caused by elevated agricultural practices with steep slopes, inadequate plant cover, and intensive agriculture, according to research findings by (Hurni et al., 2016). Such deterioration decreases crop productivity, raises populations' vulnerability to food security, and accelerates overall environmental degradation altogether through dam siltation, biodiversity loss, and reduced water availability.

A researcher finding (Tilman *et al.*, 2002), suggested that discussion of the problems of increasing output while protecting ecological reliability in addition to community physical condition requires safeguarding the sustainability of agricultural and eco system facilities. To alleviate the effect and recover ecological systems, soil and water maintenance methods have become crucial (Zhang *et al.*, 2023). SWC approaches typically lead towards reduced diversity of plants but improved yields because they have a direct impact on plant productivity and indirect effects on functional attributes and community structure. An author result (Yang et al., 2023) indicate that technological techniques promote the growth of dominant species, whereas vegetation approaches improve biomass per plant.

To decrease soil erosion in addition to enhancing agricultural sustainability, soil and water conservation practices (SWCPs) must become viable policy (A. Ayalew, 2011). Previous investigations show that SWCPs improve agricultural yields and soil fertility. Studies have proven progress in soil quality (D. Mazengia 2012 and J. Nyss 2015). For instance, research done by an author (A.K. Tebeje et al., 2024) at Debre Mawi revealed a 32.15% advancement in soil class because of SWCP operation. And, a researcher (E. Adgo, 2013), terraced cultivates in the Anjenie watershed have also shown notable yield improvements, with yield increase of 94%, 205% and 125% for Teff, barley and maize, respectively, when associated with non-terraced fields. *The government has implemented several initiatives to address these issues, although their effectiveness is seriously doubtful. On private as well as public lands, several methods for conservation, like field closures, soil bunds, and stone-faced soil bunds, have been implemented on a large scale. Promoting SWC technology requires know-how of how farmers perceive soil erosion and its effects. According to estimates from national level studies that were published in the international journal of environmental monitoring and analysis EIJEMA in 2013, about 2 million hectares of Ethiopian's highlands are beyond rehabilitation.*

This review paper analyzed different researchers' findings that were done to overcome the challenges with SWC different case studies in various areas were conducted. Therefore, this is important to evaluate the influences of soil and water conservation interventions on soil productivity and the consequences for soil production. The aim of this review study was to examine effective soil and water conservation measures implemented in Ethiopia and their role in promoting environmental sustainability.

2. An overview of Ethiopia's Soil and water conservation practices

In selectively eliminating fertile topsoil down the slope, soil erosion is a damaging course that modifies in addition changes the topsoil level and soil carbon stocks (Hurni *et al.*, 2016). Ethiopia's agricultural sector and economic growth are severely hindered by soil erosion specifically in top land locations somewhere cultivated land is severely damaged, resulting in the country's already-existing food insecurity worse (Belayneh et al., 2017). Multiple investigations acted across the country indicate that soil erosion is causing a significant amount of soil loss. For instance, an investigation in the Tigray highlands' May Zegzeg watershed revealed that the normal ratio of soil loss is approximately 14.8t ha⁻¹ year⁻¹ (Nyssen et al., 2008)

Similarly, the optimum annual soil deficit amount in the Koga River is 30.2 t ha⁻¹ yr⁻¹ including a range of 12.1 t ha⁻¹ year⁻¹ at the watershed's exit and 456.2 t ha⁻¹ year⁻¹ the steep slope area. Correspondingly, soil loss in steep parts of the Geleda watershed of the Blue Nile basin in Ethiopian's northwestern highlands can reach 237 t ha⁻¹ year⁻¹ (Tang H 2015).

Corresponding to the findings indicated above suggest that erosion rates are higher than tolerable and have an impact on the soil system's capability to produce nutrients. Additionally, rivers, fertility of land, organic soil matter, and soil biology are all destroyed whenever soil is lost.

An author (Nigussie, Z., *et al.* (2017) result revealed that the reduction of cereal yields (less than 1.2 ha) in most of the highlands indicates that a supplementary 14 million hectares cultivated land have been severely damaged which is difficult to avoid these kinds of problems. The nature of the landscape was changed through different SWCPs, such as bunds alleviated among grasslands like vetiver (*V. zizanioides*), *C. palmensis*, and additional legume crops, among others. *This indicates that, when linked to supplementary soil and stone bund stabilization methods, the combined application of physical constructions through organic or vegetative measures, particularly grasses, is extra effective in slope revolution and microecosystem maintenance.*

According to findings of (W. Mazengia 2012), the statistics indicate that soil destruction exceeds the origination of another topsoil, subsequent in minimum agricultural output in addition to a weakening in soil fertility. To solve the challenge, integrated SWC methods must be realized. Thus, preventing soil erosion has become essential for any

agricultural usage. One of the most important strategies for preventing the country's land deterioration is the protection of soil and water. It is an expression of culture and the institutions that support such kind of agricultural science.

3. Ethiopia's Performance on Soil and water conservation

A major significant approach for preventing the country's natural resource deterioration is to maintain soil and water. Several SWC strategies have been employed around the country toward reducing soil erosion and land degradation (Elhag Aydrous, A. (2015). A researcher (Beshah 2003) findings recommended that stone-based terraces and well-integrated agroforestry techniques characterize the Konso zone's conventional agricultural system. It has been around for at least 400 years. The structure's capability toward conveys culture and the organizations that strengthen this kind of farming system is its strongest point.

The survey's findings (Belayneh et al., 2017) show that the Illu Ababora Zone's Darimu and Chewaka Woredas use several kinds of native and developed methods to preserve their soil. Homegrown soil protection practices incorporate fallowing, composting, contour ploughing, crop variation and rivers; accepted soil conservation techniques in the region incorporate terracing, soil bund, fayna juu, grass strip, Chomo grass, and elephant grass.

Large-scale soil and water conservation measures were first executed on Ethiopian cultivated land in the early 1970's (Elhag Aydrous, A. (2015). For example, in the early 1980s, soil bunds were implemented in the Wolaita zone to preserve soil and water in an experimental catchment that proven moisture and nutrient consequences of conservation (Beshah, 2003). Soil loss and runoff generation are substantially diminished when soil and water conservation technologies are introduced. In the May Leiba catchment in central Tigray, northern Ethiopia, the construction of stone bunds decreases soil loss by 58 to 66 % in rangeland and 43 to 50% in cultivated lan (Taye *et al.*, 2013).

According to (Osman et al., 2000), previously SWC performances were very low when compared to current conservation advancements, indigenous soil conservation techniques on their own have become less effective. Due to un popular top-down policies and shortage of public engagement, which rendered previous attempts at modern intervention programs unsuccessful, modern ways of conserving soil and water were not practical. *Therefore, inorder to address the problems, conventional ways of conserving soil and water must be improve, and modern techniques must also be adapted to the agroecology. Participating the public group at all levels is therefore crucial.*

4. Review Methodology

This review's methodology employed a narrative review approach using secondary data, searching and compiling pertinent peer-reviewed publications and associated literature. Websites and programs from Google Scholar, Web of Science, Research Gate, Science Direct, and several other websites that publish scientific journals served as the primary basis for the selection of literature. Additionally, citations in significant works were used to find more pertinent articles. This review concentrated on the most pertinent publications rather than covering all aspects of the literature on the enhancement of soil characteristics and agricultural productivity because of soil and water conservation. Peer reviewed papers, institutional publications, and small number of unpublished sources (related PhD dissertations and MSc theses) were used as a source.

5. Types of techniques for conserving water and soil

According to research findings of (Levy-Sakin M, *et al.*, 2014) SWC measures by categorizing them into original in addition familiarized procedures while others classified them as agronomic, physical, and biological measures, identified indigenous SWC measures (locally; ditches (boyi), outdated water canal) Gorf mekded), mixed cropping, contour ploughing, crop rotation, and newly introduced SWC practices (soil bunds, stones bunds, stone faced soil bunds, hillside terrace, check dams, sediment storage dams, micro basin and cut off drain) at Gidan district of North Wollo.

Indigenous agronomic practices: According to research findings of (Elhag Aydrous, A. (2015), (following, crop rotation, and intercropping), physical practices (traditional terrace, modern terrace, soil bunds, and counter ploughing), and biological practices (agroforestry, grass strips, cutting and carrying, outdated rotational grazing, and haymaking) were found in a research done in the Bale Eco-Region. Like this, (Belay and Eyasu 2018) evaluated and categorized the main SWC measures used in Guba-Lafto district of North Wollo as biological conservation measures (afforestation, area enclosure, and grass strip), and physical SWC measures (stone bund, hillside terrace, micro water ponds, stone-faced soil bunds, check dam, and Fanya-juu terrace).

Reviewer suggests that indigenous agronomic practices like contour ploughing, intercropping, mulching, crop rotation, and natural and organic manure usage reduces runoff, minimize soil erosion, improve soil structure, and enhance moisture retention. Integrating these locally adapted practices into modern conservation programs strengthens soil and water conservation and promotes long term environmental sustainability.

Agronomic SWC techniques: mulching and crop management are examples of agronomic techniques that exploit the impact of surface covers to mitigate wind and water erosion (Adimassu, 2014). Strip cropping, mixed cropping, intercropping, fallowing, mulching, contour plugging, grazing management, and agroforestry are a few potential agronomic techniques. By boosting absorption rates, raising soil moisture content, and decreasing surface runoff, agronomic conservation techniques decrease the impact of rainfall (Nigussie, Z., *et al.* (2017). In the watershed, these agronomic preservation strategies can be used in combination with physical soil conservation strategies.

They might be more successful than structural measures in some systems (FAO (with Schweiz). (2011)



Figure 1: Contour tillage.



Figure 2 : Organic grass mulching



Figure 3: Intercropping

Based on findings from various studies, it is recommended that agronomic SWC techniques such as contour farming, crop rotation, intercropping, mulching, cover cropping, and the application of organic manure be widely promoted, as they have been observed to reduce surface runoff, minimize soil erosion, improve soil fertility, and improve soil moisture preservation, thereby contributing significantly to sustainable land management in addition to agricultural productivity.

Tillage with contours: According to (Elhag Aydrous, A. (2015), contour tillage encompasses all tillage techniques and mechanical treatments, including planting, tillage, and intercultural, that are administered over the land slope almost exactly on the contour of the region. It entails weeding, planting, and plowing along the contour that is, across the slope as opposed to up and down (Gadisa, N. (2021)). It also maintains soil, and due to increased period of intensity, further precipitation leaks through the soil profile to restore ground water. Contour furrows are crucial for reducing surface runoff and retaining rainwater until they seep through when the soil is plowing horizontally. Depending on the kind of crop, the field is plowed several times during the preparation procedure

Intercropping (mixed/intercropping) is the simultaneous farming more than two crop varieties in the same field) (Elhag Aydrous, (2015). A variety of crops can be utilized for intercropping. A common traditional technique in Ethiopia's low land area is the mixing of diverse crops using the major crops, such as safflower and teff. This strengthens crop density, variety, and land covering, protects the soil from erosion and reduces the possibility of crop failure because of insect pests and insufficient rainfall (Gadisa, N. (2021).

Mulching: Mulches, which can be organic crop residue, pebbles, or ingredients like polythene sheets, are ground covers that avoid the soil from being splashed away, decrease evaporation, increase infiltration, and control the progress of undesirable weeds (Yang et al., 2023). Mulching ceases the realization of the rigid layer afterwards each rainstorm, and natural mulches increase plant nutrients to the soil upon decomposition.

Biological SWC Measures: According to (FAO with Schweiz), (2011). The biological method mainly entails encouraging the growth of plants (grass, bushes, or trees) over the depleted measures range; the roots of these plants firmly bind the soil, while the crowns of bushes and trees provide obstacles to the flow of air or water currents; lifeless plants deliver organic materials to the soil, which in turn improves soil structure and productiveness. By cultivating plants in a way that minimizes soil deficit, it provides environmental protection.



Source: from Asfaw A (2022): the role of soil and water conservation practices

Natural vegetative strips: An author (Nigussie, Z., *et al.* (2017) findings show that certain 40-50 cm wide strips are left ploughed throughout the field on the contour when land is ploughed along contour lines. The strips natural vegetation improves water infiltration, reduces the pace of water flow, and modifies the degraded soils, making them highly useful for conserving soil and water. These naturally occurring vegetative contour strips have several advantageous characteristics according to research findings (Elhag Aydrous, A. (2015)

Physical SWC Measures: The permanent components composed of earth, stones, or masonry are known as physical soil conservation. They are designed to preserve water where it is required and protect the soil from uncontrolled movement or erosion. Steep land farming, physical features like contour bunds and rock barriers, waterways like terrace channels, diversion ditches, and grass waterways, stability structures or dams, windbreaks, and terraces like diversion, preservation, and bench are frequently required to enhance soil moisture (Nigussie, Z., *et al.* (2017). According to (Taye *et al.*, 2013)) in the May Leiba catchment, stone bunds reduced soil loss by 43–66% depending on land use type. These structures reduce slope length, slow runoff, and trap sediment (Nigussie *et al.*, 2017).



Figure 6: Physical SWC structure /soil bund/ Sources: - gozamin woreda 2018.

Source: from Asfaw A (2022): the role of soil and water conservation practices

Based on findings from various studies, it is recommended that physical SWC techniques, such as soil bunds, stone bunds, Fanya-juu terraces, bench terraces, and check dams be widely implemented, as they have been consistently observed to reduce surface runoff, control soil erosion, boost water infiltration, and improve soil moisture retention. These measures are particularly effective on sloping and erosion-prone lands; however, their success depends on proper design, regular maintenance, and active community participation.

6. Efforts of Ethiopia's Soil and water conservation Program

According to an author (W. Mazengia 2013), Ethiopian has made many attempts to preserve water and land, primarily beginning in the 1980s. Bunds made of soil and trenches, mostly in agricultural areas, are formed by district level community mobilization; these soil bunds incorporated including fodder trees, primarily *Sesbania*, were put into place beginning on the specified date.

FAO with Schweiz, (2011), indicate that, Ethiopia's efforts to preserve soil and water include food for exertion, handling ecological resources to facilitate the shift to supplementary sustainable livelihoods, the national sustainable land management development, productivity safety net programs, and community mobilization through free labor days. In Tigray region land degraded land management through SWC has demonstrated benefits in terms of soil structure, crop yield, biomass production, infiltration capacity, groundwater recharge, and flood hazard prevention.

According to (Gadisa, N. (2021), findings the removal of remnants vegetation has been increasing over the past few decades, according to research on land utilization and land cover modification; however, due to the government's set-aside policy, this trend has slowed or even reversed in some parts of northern Ethiopia. In previous studies, (A.K. Tebeje, et al., 2024) discovered locations with increased human densities, particularly in the past 20 years, had much more woodland vegetation and SWC buildings. According to some experts, like (Nigussie, Z., et al, 2017) attempts to conserve water and soil either have no effect at all or are even detrimental.

However, the moisture method and the age of the structures affect how successful SWC methods are. According to Gadisa, N. (2021), grass waterways are further suitable for usage in high rainfall regimes, while soil bunds, stone bunds, and grass strips are more successful in low rainfall regimes. According to (Yang, G., et al., (2023), efforts to sustain soil and water in the Ethiopia highlands will be less successful in wet regions than in semiarid ones. An author (A.K. Tebeje, et al., 2024) discovered that stone bunds and trenches are only completely successful in the first year of construction when it comes to decreasing runoff and soil loss in the semi-arid Ethiopian highlands.

Herweg and Ludi (2015) conducted a study to evaluate the efficiency of various SWC techniques, including soil and stone bunds, dual ditches, terraces, especially fanyajuu, and grass strips, in various regions with separate agroecology. They found that these techniques did not result in a net increase in crop productivity and biomass production. Similarly (A.K. Tebeje, et al., 2024) said that because the net value of crop income for plots with fanyajuu terraces is lower than that of plots without them, fanyajuu terraces cannot be considered a successful strategy to decrease soil erosion.

In contrast, alternative case study from Anjeni location by (Gadisa, N. (2021)) found that smallholder farmers benefit in the long run from SWC measures. Stone bunds produced a 50 % rate of return, according to research conducted in Tigray, Northern Ethiopia, by (A.K. Tebeje, et al., 2024) on the consequences of stone bunds on agricultural outcome and farm profitability. However, despite the average 53% increase in grain yield, the cost of constructing stone bunds is almost equal to the value of the induced crop yield increase, according to another study done in the same region (Nigussie, Z., et al. (2017).

Ethiopia's SWC program has been implemented since the mid-1970s to address land degradation and improve agricultural productivity through integrated watershed management approaches. The program emphasizes physical measures such as soil and stone bunds, terraces, check dams, and gully rehabilitation, combined with biological interventions including afforestation, area closures, and agroforestry. National initiatives such as the sustainable land management program, the PSNP, and the Green Legacy initiative have mobilized communities and stored degraded landscapes with support from extension services and NGOs. Despite notable achievements in decreasing soil erosion in addition refining soil moisture, challenges related to maintenance, institutional capacity, and community participation persist, requiring more integrated and participatory approaches for long-term sustainability.

7. Environmental Sustainability

ES focuses on maintaining soil health, water resources, biodiversity, and climate regulation functions, which are fundamental for long-term human well-being and economic stability (FAO, 2011). Effective SWC practices reduce soil erosion, improve soil fertility, enhance water infiltration, and restore degraded ecosystems, thereby supporting sustainable agricultural production and ecosystem services (Hurni et al., 2016; FAO, 2011). In Ethiopia, integrated SWC measures such as physical bunds, biological conservation, and agronomic practices contribute to environmental sustainability by stabilizing landscapes, increasing vegetation cover, reducing sedimentation of water bodies, and enhancing climate resilience (Jiru & Wegari, 2022).

8. Challenges

Despite positive impacts, several challenges limit SWC effectiveness. These include high labor and construction costs, inadequate maintenance, limited institutional support, and insufficient community participation Tebeje et al. (2024). Some studies also report limited or negative short-term yield effects for labor-intensive structures such as Fanya-juu

terraces (Herweg & Ludi, 2015). However, survival rates of planted seedlings and regional inconsistencies highlight the need for sustained ecological management and enhancement of post-planting support systems.

7. Conclusion

This review paper was carried out the effective measurement of soil and water conservation in Ethiopia. The finding stated that to increase the productivity of different varieties of crops in the country, effective action needs to be addressed through preventing the challenges observed in SWC techniques. The review paper intentions to review different findings on the success of SWC conservation for environmental sustainability having the main emphasis on the consequences aimed at soil productivity and sustainability. Despite the agricultural sector's significant economic contribution, soil erosion and decreased soil productivity poses a threat to it. As discussed earlier, soil erosion and land degradation deteriorate the physical, chemical, and biological characteristics of the soil, resulting in yield losses that impact the capacity of the soil to be productive and function effectively.

However, most of the investigation discovered and contrasted in this review indicates that the application of structural soil and water conservation decreased soil losses and runoff. This enhances the soil's physicochemical characteristics and agricultural land's productive potential by reducing the loss of associated nutrients and organic matter from the soil. Therefore, compared to agricultural cultivated land without soil and water conservation, conserved farmland has a higher crop yield and soil productive capacity. In conclusion, structural SWC interventions had a significant impact on the development of soil physicochemical properties in various regions of the country, which were able to increase crop yield and soil productive capacity. The following recommendations have been provided to successfully apply SWC and enhance soil qualities based on the research reviewed and the writer's own experiences in the field. Most Ethiopian's soil conservation structure methods don't rely on conventional approaches; thus, they must adhere to them. The main challenges in Ethiopia are inadequate examining and assessment of soil and water conservation, a look of integrated bio-physical measures, and a failure to take socioeconomic profile into consideration.

References

1. Alemayehu, T. & Fisseha, G., (2018). Effects of soil and water conservation practices on selected soil physicochemical properties in Debre-Yakob Micro-Watershed, Northwest Ethiopia. *Ethiopian Journal of Science and Technology*, 11, 29-38.
2. Ayalew A. Construction of soil conservation structures for improvement of crops and soil productivity in Southern Ethiopia. *J Environ Earth Sci*. 2011;1(1):21–9.
3. A.K. Tebeje, et al., Dynamics of soil quality in a conserved landscape in the highland sub humid ecosystem, Northwestern Ethiopia, *Front. Sustain. Food Syst*. 8 (2024).
4. Adimassu, Z., Mekonnen, K., Yirga, C. & Kessler, A., (2014). Effect of soil bunds on runoff, soil & nutrient losses, *Land Degradation and Development*, 25, 554-564.
5. Beshah T. Understanding farmers explaining soil and water conservation in Konso, Wolaita and Wello, Ethiopia. PhD Thesis, Wageningen University Research Center; 2003.
6. Belayneh M., Abera A., Tadesse G., (2017). Soil Degradation and Conservation Practices: Illu Ababora Zone, Ethiopia. *International Journal of Scientific and Research Publications*, 7, 562
7. Taye G., et al., (2013). Effects of land use, slope gradient, and soil and water conservation structures on runoff and soil loss in semi-arid northern Ethiopia. *Physical Geography*, 34, 236259.
8. Elhag Aydrous, A. (2015). Effect of Micro Catchment Techniques on Vegetative Growth of *Jatropha* (*Jatropha Curcas*). *American Journal of Agriculture and Forestry*, 3(2), 52. <https://doi.org/10.11648/j.ajaf.20150302.17>
9. FAO (with Schweiz). (2011). Mountain forests in a changing world: Realizing values, addressing challenges; [International year of forests 2011] (M. F. Price, Ed.). FAO.
10. Field, C. B., et al., (2014). *Climate change Impacts, adaptation, and vulnerability*: Cambridge University Press.
11. FAO. (2018). Food and Agriculture Organization of the United Nations (2018), FAOSTAT Database, Rome, Italy
12. Gadisa, N. (2021). Soil and Water Conservation Measures in Ethiopia: *World Journal of Agriculture and Soil Science*, 6(3). <https://doi.org/10.33552/WJASS.2021.06.000636>
13. K. Hurni, et al., 2015: Economics of Land Degradation (ELD) Ethiopia Case Study: soil degradation and sustainable land management in the rainfed agricultural areas of Ethiopia, An assessment of the economic implications.
14. Osman M., et al., (2000). Land and Water Resources Management in Ethiopia: What did we learn, where do we go? Deutscher Tropen tag, Hohenheim.
15. H. Hurni, et al., 2016 Soil and Water Conservation in Ethiopia: Guidelines for Development Agents.
16. Malmberg, K., et al., (2018). Mapping regional livelihood benefits from local ecosystem services assessments in rural Sahel. *PLOS ONE*, 13(2), e0192019. <https://doi.org/10.1371/journal.pone.0192019>
17. Nyssen, J., et al., (2007). Dynamics of soil erosion rates and controlling factors in the Northern Ethiopian Highlands –, published online in Wiley Inter Science.156.
18. Sharma, S. K (2018). An analysis of multiple ecosystem services under future oil palm expansion scenarios in Central and West Kalimantan, Indonesia. Center for International Forestry Research.

19. Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, 418(6898), 671–677. <https://doi.org/10.1038/nature01014>
20. Yang, G., et al., (2023). Dissolved organic matter evolution and straw decomposition rate *Journal of Environmental Management*, 344, 118537. <https://doi.org/10.1016/j.jenvman.2023.118537>
21. Zhang, Y., et al., (2023). Soil and water conservation measures reduce erosion in Agriculture, *Ecosystems & Environment*, 346, 108346. <https://doi.org/10.1016/j.agee.2023.108346>
22. W. Mazengia, J. Mowo, Role of collective actions in integrated soil and water conservation: the Case of Gununo Watershed, Southern Ethiopia, *J. Dev. Agric.Econ.* 4 (1) (2012) 23–36.
23. J. Nyssen, et al., Land management in the northern Ethiopian highlands: local and global perspectives; past, present and future, *Land Degrad. Dev.* 26 (7) (2015) 759–764.
24. E. Adgo, A. Teshome, B. Mati, Impacts of long-term soil and water conservation on agricultural productivity: the case of Anjenie watershed, Ethiopia, *Agric. Water Manag.* 117 (2013) 55–61.
25. Hurni H. Degradation and conservation of the resources in the Ethiopian highlands. *Mountain Research and Development*. 1988;123-130.
26. Tang H, et al., 2015 Jan 13;16(1):3. doi: 10.1186/s13059-014-0573-1. PMID: 25583564; PMCID: PMC4305236.
27. Levy-Sakin M, et al., 2014 Jan 28;8(1):14-26. doi: 10.1021/nn4050694. Epub 2013 Dec 20. PMID: 24328256; PMCID: PMC4022788.
28. Nigussie, Z., et al, (2017). Factors influencing small-scale farmers’ adoption of sustainable. *Land Use Policy*, 67, 57–64. <https://doi.org/10.1016/j.landusepol.2017.05.024>
29. National Bank of Ethiopia. (2020). Annual Report 2019-2020. Addis Ababa, Ethiopia
30. World Bank, 2006. Africa Development indicators 2006. Washington DC.

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