International Journal of Sustainability Management and Information Technologies
2023; 9(2): 28-36
http://www.sciencepublishinggroup.com/j/ijsmit
doi: 10.11648/j.ijsmit.20230902.13
ISSN: 2575-5102 (Print); ISSN: 2575-5110 (Online)

Review Article

Review on Role and Challenge Adoption Sustainable Land Management Practices in Highland of Ethiopia

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To cite this article:
Assen Yesuf Ali. (2023). Review on Role and Challenge Adoption Sustainable Land Management Practices in Highland of Ethiopia. *International Journal of Sustainability Management and Information Technologies*, *9*(2), 28-36.
https://doi.org/10.11648/j.ijsmit.20230902.13

Received: November 19, 2023; **Accepted**: December 9, 2023; **Published**: December 22, 2023

Abstract: Land degradation is critical problem agriculture production in the Highlands of Ethiopia resulting significant reductions of agriculture GDP. The cause land degradation was resettlement, plough on steep slopes, deforestation, overgrazing and increase of demand of firewood. Therefore, these paper review on the on role and challenge adoption sustainable land management practices in highland of Ethiopia. In order to mitigate ongoing soil erosion and nutrient loss in the productive agricultural high land's of the country, the government of Ethiopia a sustainable land management program since 2008. The challenges of the adoption sustainable land management practices in Ethiopia are open grazing, poor implementation of regulation and by law, land fragmentation and lack of sense of ownership for the soil and water conservation structures. The role of sustainable land management to address environmental problems, increase agricultural productivity, crucial of minimize of land degradation, and rehabilitated degraded area. Should be recommendation to Policy makers should take into consideration the challenge of adoption of SLM practice when designing and implementing introduced Sustainable land management practices.

Keywords: Adoption, Ethiopia, Highlands, Land Degradation, Sustainable Land Management

1. Introduction

The agriculture sector has played and continues to play a leading role in economic growth, poverty reduction, and development. In Ethiopia, agriculture provides employment opportunities for more than 80% of the population, contributes about 50% to the national Gross Domestic Product (GDP), and accounts for 84% of all exported goods [66, 69]. The severity of the problem is high in developing countries where natural resources are the primary source of livelihood for most people [34, 45]. However, land degradation in the form of soil erosion and soil nutrient decline is severely threatening agricultural production in the densely populated Ethiopian highlands [52]. The majority cause of land degradation in Ethiopia is rugged topographical feature, unsustainable land use, highly populated cultivation on steep slopes, high population pressure, clearing of vegetation and overgrazing.

Land degradation has been a major global challenge throughout the 20th century high on the international agenda in the coming century [13]. Sub-Saharan Africa (SSA) is particularly vulnerable to threats of natural resource degradation and poverty especially soil erosion [19]. A large portion of the agricultural land, which is mainly located in the highland part of the country, is affected by severe to moderate land degradation [28].

Adimassu *et al.*'s study reviewed that in Ethiopian highlands the loss of soil is between 42 and 175.5 t ha^{-1} year^{-1} [6]. Other studies in different part of the country also reported substantial amount of soil loss. For instance, 118 ton^{-1}year^{-1} [2], 65.9 ton^{-1}year^{-1} [7], 45 ton^{-1}year^{-1} [38] and 30 ton^{-1}year^{-1} [61] in Bench Maji Zone, Northeast Wollega, Chaleleka wetland catchment and Tana basin, respectively.

The impact of land degradation was influence, crop production, soil erosion and food security. Land degradation negatively effect on livelihoods inhabitants in southwest Ethiopia increased from time to time. Losses of closed Afromontane Forest area [35] to agriculture land have enormous consequences on physical soils properties (reducing soil depth, decrease of water-holding capacity) and chemical

properties (nutrient depletion, reduction of the amount of soil organic matter [36, 56] and reducing environmental services such as filling of sediment [37]. To address problem the land degradation problem different partner would be participation implementation sustainable land management practices.

Sustainable land management practices such as soil and water conservation, soil fertility management, controlled-grazing and other land management practices were introduced [62]. The sustainable land management practices have been practiced under the food for work program, managing environmental resources to enable a transitional to more sustainable livelihood, productivity safety net program, the community mobilization through free Labor Day and sustainable land management (SLM) project [32]. According to Gessesse *etal.* reviewed that sustainable land management comprise measures and practices adapted to biophysical and socio-economic conditions aimed at the protection, conservation and sustainable use of resources and the restoration of degraded natural resources and their ecosystem function [30]. The adoption of sustainable land management practices/ technologies have significant quite crucial to increase agricultural productivity, ensure food security and improve the livelihoods of smallholder farmers [59].

Erkossa *etal*. [24] in Western Ethiopia, Atikilt *et al*. [10] in Northern Ethiopia, and Masha etal. [45] in Southern Ethiopia showed that plots with SWC practices like soil-bound and stone-bound produced higher yields than those without. However, studies conducted by Adimassu *etal*. [5] in central Ethiopia and Abera *eta*l. [3] in highland Ethiopia, assessed that no significant productivity differences between conserved and non-conserved cultivation land. The review by Adimassu etal. [6] and Guadie *etal.* [31] stated that in Ethiopia implementation soil bunds and stone bunds negatively impact crop yields because the built structures reduce the size of the cultivatable land.

The adoption land management practices were challenge by age, education, family size, the slope of the plot, tenure security, training, access to farm credit, and extension service [71]. Eshetia, reviewed that, in Ethiopia major challenge the adopted of different land management practices were off-farm activity, shortage of land and low perception of farmer [25]. In geneally, the low perception of farmers on newly introduced SLM practice, shortage of land and high labour required due to of these still minimal adoption of sustainable practice practices. For these review objectives to examined role and challenge of adoption sustainable land management practices in highland of Ethiopia.

2. Literature Review

2.1. Types of Adoption Sustainable Land Management Practices

In Ethiopia's in highlands, the high rate of soil loss is the major problem. The average soil loss rate in the upper Blue Nile basin ranges from 28.68 t ha^{-1} yr^{-1} to 57.98 t ha^{-1} yr^{-1} [21, 22]. Since, 1970s, to minimized problem land degradation due to of these provide increase crop productivity in Ethiopia adopted different sustainable land management practices [27, 43, 45, 64].

The sustainable land management program was started with the agreements signed between the Government of Ethiopia and the World Bank in 2008 to minimized land degradation, increasing land productivity and improving farmer livelihoods. The SLM and natural resource conservation practices in Ethiopia since the early 1970's to date include a range of physical soil and water conservation measures, such as stone/soil bunds, farmland and hillside terracing and check-dams, gully rehabilitation cut-off drains and waterways, micro-basins water harvesting structures like ponds and farm dams, spring development, as well as biological measures, such as tree planting at homestead and on farm (agro-forestry trees) reforestation, area enclosures and management [16]. Tadele, [62] identified that in Bale Eco-Region different soil and water conservation practices such as indigenous agronomic like relay cropping strip cropping and intercropping, physical practices such as stone bund, soil bund, fannjuu and bench terrace and biological SWC practices like Agroforestry, vetiver and desho grass. SWC practices like Agroforestry, vertiver and desho grass. According to studied by, Belay and Eyasu [11] classification of the SWC practice adopted in Guba-Lafto Woreda of North Wollo as physical SWC practices such stone bund, hillside terrace, micro trench, eye brow basin, bund, check dam, and fanya-juu, agronomic soil and water conservation practices like agroforestry, relay cropping, and intercropping.

Konso people are known society by their indigenous soil and water conservation practices for which they were registered by United Nations Educational, Scientific and Cultural Organization [49]. According to Yirdawa *etal*., [73] reported that traditional soil and water conservation practices were as terracing land, contour ploughing land and crop rotation are the mechanism used to reduce soil erosion in Konso people in south west Ethiopia. In the bench terrace by the Konso people and Gedeo's agroforestry systems are best among the important attributes of indigenous practice in agricultural development in Ethiopia [53, 54].

The introduced sustainable land management are common understanding knowledge about the implementation of each practice people in the world to perform different type of structures, which have known standard length, width and height and universal acceptance [18]. According to the author, [12] identified that introduced land management practices in Ethiopia adopted such as soil bund, stone bunds, bench terrace, inorganic fertilize, check dam, waterways, cut off drains, area closure, hillside terrace and fanya-juu.

Table 1. *Classification of SLM practices.*

Nº	Classification of practice	Principles	Practices
1	Integrated soil fertility management (ISFM)	1. Maximization of different organic sources of fertilizer 2. Wise in organic fertilizers	Intercropping Compost
2	Conservation agriculture (CA)	1. Inter cropping 2. Crop rotation	Mulching Fallowing.
3	Soil and water conservation	1. Rainwater collection 2. Soil erosion control 3. Strorage system	Stone bund, micro basin, bench terrace, zai and half moon
4	Integrated agriculture and livestock management (IALM)	Agriculture and livestock interact to create synergies	Marine use, night pens, forage plantings, hay production
5	Agroforestry and individual forests (AF)	1. Integration of crops with livestock, 2. crop with forest, 3. crop with livestock and forest	Alley cropping, shrub, livestock
6	Adaptation to climate change (ACC)	1. Planting resistant harsh environment plant 2. Reduction of the time of exposure to climatic risks (drought, floods)	Seed priming, drought tolerant varieties, climate smart agriculture (CSA)

Source: Diogo *et al.,* (2017)

Stone bund is one of the SLM practices used to prevent soil losses by agents of run off on sloppy areas. Stone bound structure provides to improve soil fertility, increase water retention and improve land productivity. According to Nigatu *etal.,* [57] reviewed that implementation stone bunds land management practices have been used for soil erosion control, to conserve *in-situ* moisture and decrease sheet and rill erosion. Erkossa *etal.* [24] in Western Ethiopia, Atikilt *etal.* [10] in Northern Ethiopia, and Masha *etal.* [45] in Southern Ethiopia showed that plots with SWC measures such as soil-bound and stone-bound produced higher yields than those without. However, studies conducted by Abera *etal.* [3] in the highlands of Ethiopia; demonstrated no significant productivity differences between conserved and non-conserved plots. The review and synthesis conducted by Adimassu *etal.* [6] and Guadie *etal*. [31] in Ethiopia stated that stone bunds negatively impact crop yields because the built structures reduce the size of the cultivatable land.

Figure 1. *Level Fanyaa juu in Kechema in Adama woreda.*

Fanya Juu is an embankment along the contour construct with soil a channel at its lower side where overflowing runoff is collected. To sustain of structure on the top of the embankments planting with the different grasses and seedling species used to animal fodder like vertiver grasses, desho grase and sasbania. This practice used to reduce runoff velocity and minimize soil erosion. retain soil moisture and increase land productivity. The different authors [20, 48] also indicated the Fanya juu is one soil and water conservation structures to provide effectively controlling erosion and improve the productivity of land.

Bench terraces abench terrace is one of practice constructed where a slope land is converted in to level of land, to created new cultivation land of the farmer. Bench terrace to minimize runoff or with a slight gradient to allow for drainage of excess flows. Nyangena and Kohlin [58] assessed that bench terraces employed on steep slopes a positive effect of agricultural productivity in Machakos districts in Kenya.

Photo Assen Yesuf

Figure 2. *Bench terrace in Semen bench woreda.*

Photo: Zenebe Adimassu, IWMI.

Figure 3. *Bench terrace in Konso.*

Area enclosure is excluded degraded from livestock and humans to rehabilitation of the degradation of land. The process of area closure has been one of the strategies for rehabilitating degraded lands within the catchments delineated for rehabilitation and soil and water conservation program. According to Wondie *etal.* [68] assessed that area enclosure is effective to improve soil properties and nutrient content.

Figure 4. *Apiculture in area closure Amhara region.*

Planting grass species. The planting different grass species for animal fodder, controlling of soil erosion and increases water infiltration. The grass species like desho grass, vetiver grasses and elephant grass the most time implementation of the farmland. According to Endale and Buchura [23] assessed that the role of Vetiver Grass for Soil and Water Conservation in Ethiopia to reducing soil erosion, improving soil fertility and conserve soil moisture.

Figure 5. *Vetiver and Elephant grass in Benshalgulgumz.*

Trenches: These structures are constructed on top of cultivated land to remove excess water safely to lower part the land. The constructing the trench reduces the rate of runoff, increase in percolation rate and increasing the soil moisture to vegetation. According to Amsalu [9] assessed that the construction of soil and water conservation practices in Beressa watershed in highlands of Ethiopia on steep slopes used to control of soil erosion.

Figure 6. *Trench in Semen Bench Woreda.*

Crop rotation: This is of most the indigenous practices implementation for long time farmer one crop species after harvest sowing with other crop type for improve soil fertility. The crop rotation used like maize, wheat, teff, soybean, and sorghum, sweet potato and cabbage to improving soil productivity and controlling of soil erosion implemented most part Ethiopia. According author [15] who reported that crop rotations to enhance soil fertility by improving surface cover incorporating nitrogen fixing leguminous crop with rotation cereal crop sequences for better yield.

Figure 7. *Crop rotation where Maize was rotated with Faba bean in Urga Woreda.*

Agro forestry: is the traditional practice of planting with different of trees or shrubs with in cropland and/or pasture lands to the function of economic and ecological benefits. Agro forestry to minimize soil erosion and achieving food security of household. According to Temesgen *etal.* [63] also reported that agro-forestry practices are highly expanding South Eastern Rift escarpment of Ethiopia, which has a significant contribution to soil fertility, access to water, fodder and keeps up the balance of ecosystem.

Contour ploughing: this is one of traditional practice farmers plough with horizontal to minimize of soil erosion in cultivation land. Contour ploughing is importance of controlling of soil erosion and infiltrations of rain water in ground. According to Motuma [55] also assessed that counter plough is indigenous practice of cultivate the land along the contours of the line in order to reduce the velocity runoff water.

2.2. Challenge of Adoption Sustainable Land Management Practices in Ethiopia

Different type of challenges adopted of sustainable land management practices in Ethiopia. In Ethiopia challenge of adopted the different land management practice were lack of appropriate land management, over grazing, poor implementation of regulation and by law, inappropriate construction of natural resource conservation structures, land fragmentation, lack of sense of ownership for the soil and water conservation structures and land degradations problem. The adoption in Ethiopian sustainable land management practices negatively influenced by socio-economic, biophysical and institutional factors [1, 4, 65]. It also sustainable use is highly affected (among other factors) by bio-physical and institutional aspects of land such as land quality, land fragmentation and tenure systems [65]. Plot level characteristics such as soil fertility status, slope of plots, and location of the plot influence the continued use of sustainable land management practices as well as, availability of labor force, land holding, crop production, and farm input utilization were found to have an influence sustainable land management practice [65]. According to Eshetie, [25] also the major problems affecting farmers to implement SLM practices where small family size, lack of grazing lands or open access to grazing, the small size of land and farm experience of farmers.

The adoption of introduced soil and water conservation practices in Wereillu Woreda negatively influenced with age, off-farm activity and distance of farmlands [17]. According to Mengie *etal.,* [46] assessed that in Darimu and Chewaka woredas of Illu Ababora Zone the challenge the implementation soil and water conservation influenced by weak extension services, sex of the household, insecure land tenure and off farm activities. Abebe and Sewnet, [1] reviewed that in northwest Ethiopia introduced soil and water conservation practice influenced personal factors were age, education of household and low perception of practices. The adoption soil and water conservation structure constraint in northern highlands of Ethiopia were labor, farmland size, social capital and access to information [52].

In otherwise, Mamuye [44] identified that in Werra Jarso District constraint of sustainable land use management were population growth, income level, urbanization, and land tenure and property rights. Due the different influenced factor adoption introduction of sustainable land management practices in the Highlands of Ethiopian still very low [42].

2.3. Role of adoption Sustainable Land Management

The majority of people in Ethiopia depend directly on agricultural production but the occur severity of the soil erosion time to time due of these decreases of agricultural production. To solve these problems, in Ethiopian government implemented different type of sustainable land management practices since the 1970s [27, 43]. The address of the soil erosion problem in the high land of Ethiopia different land management practice implementation like contour plough, stone bund, compost, crop rotation and bench terrace to protection the soil erosion, increase /maintain water stored in soil. Land management is encompassing all activities associated with the management of land that are required to achieve sustainable development [25]. The purpose of sustainable land management practices is to reduce soil erosion by implementing physical SWC structures and enhance soil fertility by improving surface cover using biological measures and agronomic practices such as, crop rotation, fallowing, intercropping, applying animal/green manure, and composting and also, reduce water losses through water harvesting infiltration and storage, improving irrigation, and managing surplus water [15].

The adoption SLM improved yields and crop diversity for smallholder farmers provide the basis for greater self-sufficiency in local food production [33]. SLM practices importance of the increase of agricultural productivity, increasing income and enhancing food security through reducing erosion, improving soil fertility [14, 50, 60]. According to Abebe, [2] assessed that in Adwa and Amba Alagie district in Tigray region in crop yield significance difference between of adopter households and non-adopter households.

The different sustainable land management practice such as physical soil and water conservation practices, biological measures and soil management practices, have been introduced by governmental and non-governmental organizations to reduce of soil erosion and increase food production [57]. Sustainable land management practices were implementation to reduce the soil erosion and soil loss in the Highlands of Ethiopian [42, 72]. Otherwise, SWC measures implementation in Debre-Mawi watershed of Amhara region resulted in considerable reductions in storm water runoff from 26-71% and sediment yields from 45- 81% [47] and in Chena district of SNNPR, SWC adoption reduce the rate of soil erosion after intervention [71].

The adoption of sustainable land management to reduce of soil erosion, improved of soil fertility and increase agricultural productivity in highland Ethiopia. Kassie *etal*. [39] assessed that implementation of sustainable land management positive significant effect on crop yield in Tigray and Amhara region. According to Alemayehu [8] assessed that terraces were implementation importance to enhanced soil fertility, minimization of soil erosion and increased crop yield in West Gojam Ethiopian. Contrary, Kassie *etal.* [41] assessed that employed plots of land with SLM in high rainfall areas resulted in lower yields compared to plots with not SLM in Amhara region because of water logging.

3. Materials and Methods

3.1. Description of the Review Area

Location map of Ethiopia and topographic map of the country, showing the Ethiopian administrative regions and the capital city of Addis Ababa. This review was conducted in Ethiopia. It lies between 6° 00’ 0” and 14° 00’0” N latitude

and 35° 00'0" to 48° 00'0" E longitude (Figure 8). Located in East Africa, Ethiopia is found in the Horn of Africa. It is completely landlocked, bordered by Sudan in the west, Somalia and Dijbouti in the east, Eritrea in the north and Kenya in the south. The cover a total area of Ethiopia 1,112,000 km^2.

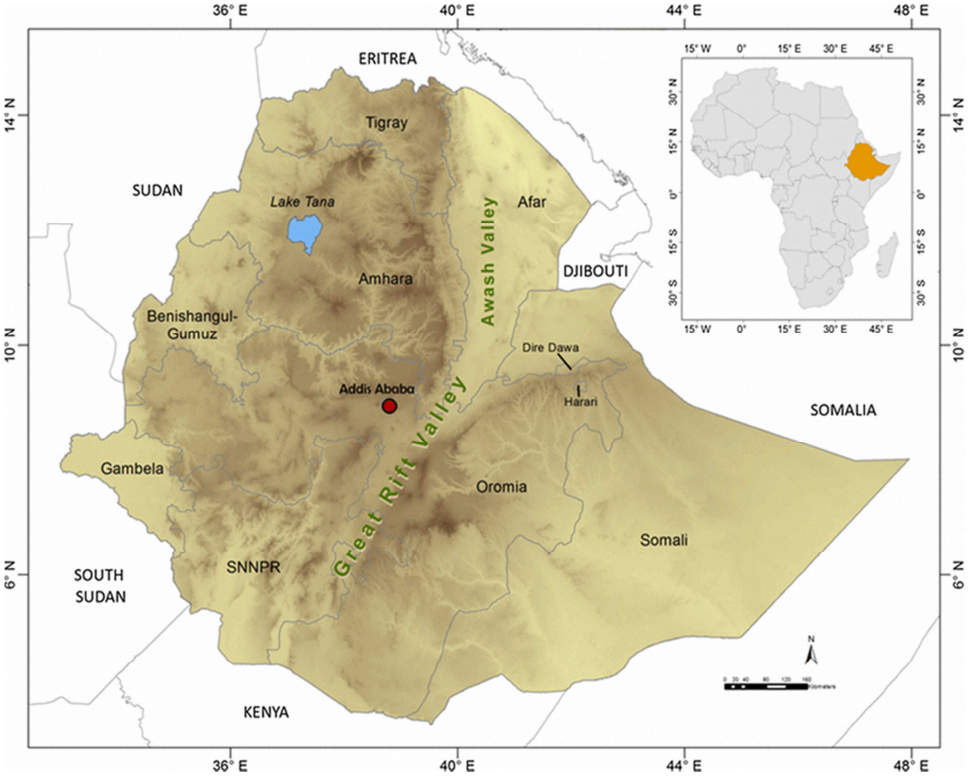

Figure 8. *Location Map of the Ethiopia.*

3.2. Biophysical Characteristics of the Study Area

The agro-ecological Zones in Ethiopia are classified into three categories based on altitude Weinadega, kola and Dega, respectively.

The topography of the area comprises different land futures like flat area, rugged topography, plateau and steep sloppy areas. It is a land of natural contrasts, with its vast fertile west, jungles and numerous rivers and the world hottest settlement of Dallol in its north. The Ethiopia highlands are Africa largest continuous mountain range and Sof Omer Caves contain Africa largest cave.

Ethiopia is mountainous with some twenty peaks above 4,000 m (13,123.36 ft). The highest point is Ras Dashen, located in the Simien Mountain Range, it reaches 4,620 m (15,157.48 ft) making it the third-highest mountain in Africa. The Simien Mountains are located in northeast Ethiopia. Another well-known range in the country is the Bale Mountains which are separated from the highlands by the Great Rift Valley. The highest peak in this range is Tullu Demtu at 4,377 m (14,360.24 ft). The chief river in Ethiopia is the Awash River; however, other large river basins found in the country include the Blue Nile, the Baro River, and the Omo River.

The mean annual rainfall of Ethiopia ranges from 141mm in the arid area of eastern and northern eastern borders of the country to 2275mm in the southwestern highlands. In Ethiopia different soil type occure like, Leptosols are dominant on crests, while Nitisols are dominant on the hill slopes and Fluvisols are found in the flat valley bottoms where meandering rivers occur.

The major land-use and land-cover classes in the in Ethiopia include cultivated land, grassland, forest land, shrub land, built-up areas and water bodies. In the study area occurring different vegetation species includes: Girar *(Acacia abyssinica), zigba, warka,* Wanza *(Cordia africana),* Bissana *(Croton machostachys),* and Tikur inchet *(Prunus africana*), Key bahirzaf *(Eucalyptus camaldulensis),* Weyra *(Olea europaea),* Lenkuta *(Grewia ferruginea),* Tid *(Juniperous procera)*, Sesa (*Albizia gummifera*) and Coffee (*Coffee arabica)*.

3.3. Population and Socio-Economic Activities

Ethiopia is a multilingual nation with above 80 ethno linguistic group. The tenth-largest country in Africa in size; Ethiopia is the second-most populous country on the continent. According to the 2022 population projection of Central Statistics Agency in Ethiopia the total population of the study area is estimate to 120 million people (CSA, 2022).

The livelihood of the community is mainly based on farming system. The major crops grown were wheat, barely, teff, sorghum bean, maize and cash crop commodities are cultivated such as chat, mango, coffee, lemon, avocado, papaya and banana. Ethiopia is the place of origin for the

coffee bean which originated from the place of kefa. In addition, root and tuber crops grown such as; Sweet potato, potato, onion, carrot, Enset and Taro. The main livestock species reared were cattle, sheep, goat, donkey, horse and mule in Ethiopia.

3.4. Sources and Types of Data

The collected data from secondary like relevant published and unpublished documents such as journal articles, district annual report documents, census records, project reports, research papers and data files from web sites.

4. Conclusion and the Way Forward

Land degradation is one of the major challenges in agriculture production in high land Ethiopia. The cause of land degradation in Ethiopia is rugged topographical feature, unsustainable land use, highly populated cultivation on steep slopes clearing of vegetation and overgrazing. These of problem land degradation and declining soil fertility across the country have affected the country have affected the agricultural productivity and food security. To address of Ethiopia's these environmental problems, agricultural productivity and land degradation adoption of different sustainable land management practice. The main objective of to reviewed role and challenge adoption sustainable land management practices in highland of Ethiopia. The role adoption of the sustainable land management technology can help achieve to minimize erosion, restore soil fertility, rehabilitate degraded land and increase agricultural productivity. The challenges of the adoption sustainable land management practices were open grazing, poor implementation of regulation and by law, inappropriate construction of natural resource conservation structures, land fragmentation and lack of sense of ownership for the soil and water conservation structures, socio-economic and institutional factors. Based on the literature reviewed that to recommendation when designing and implementing introduced SLM practices to incorporate the farmer adoption of integrated SLM practice to advanced use for mitigation of climate change and protect soil erosion.

Conflicts of Interest

The author declar that have no conflict of interest.

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