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Systematic Review on Adoption of Soil and Water Conservation (SWC) Practices among Farmers in Ethiopia: Implication on Factors Affecting Acceptance and Continuous Use of SWC

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Abstract: ***In Ethiopia, soil erosion is the most dangerous ecological process observed and has been given a very important place in the countries soil conservation programs. Recognizing the contribution of soil and water conservation to reduce land degradation which is a major environmental and socio-economic problem, the government of Ethiopia has made several interventions. To this end, moreover both governmental and non-governmental organizations are engaged in the promotion of soil and water conservation practices in Ethiopia, but the adoption behavior of farmersto maintain and sustain SWC measuresis believed to be low and not fully integrated in the household's farming system. Here adoption behavior refers to the degree to which farmers are intrinsically motivated to maintain and replicate SWC measures. Thus, the review indentified the determinants of adoption of soil and water conservation practices in the countryand assessed farmers awareness and attitude to sustain improved SWC practices in the country. Data for this systematic review were collected from different literatures, reports and documents related to the topic. The review identified the major determinants of adoption of soil and water conservation practices such as Physical factors, psychological, socio-economic and institutional factors and also investments byfarmers in soil and water conservation (SWC) practices are influenced by the physical effectiveness, financial efficiency, and socialacceptabilityof the practices. Therefore, major policy implication of the review is strengthening and designing SWC strategies and programs in consideration with agro ecology of the intervention area as well as those mentioned factors since different SWC strategies and programs have diverse physical and socio-economic characteristics.***

Keywords: Adoption, determinants, soil and water conservation, Ethiopia

1. Introduction

Land degradation has been a major global agenda because of its adverse impact on environment and food security and the quality of life (Slegers, 2008). Productivity impacts of land degradation are largely due to decline in soil depth and soil fertility (Falkenmark *et al*., 2009; Stroosnijder, 2009) and off site where sediments are deposited (Pender and Gebremedhin, 2007). The situation is severe in the Ethiopian highlands where land degradation has rendered vast areas of fertile lands unproductive (Gilligan and Hoddinott, 2007; Kassie *et al*., 2010).

Agriculture is the major source of livelihood in Ethiopia. However, land degradation in the form of soil erosion has hampered agricultural productivity and economic growth of the nation (Balana et al., 2010). Land degradation, low agricultural productivity and poverty are critical and closely related problems in the Ethiopian highlands (Pender and Gebremedhin, 2007; Yitbarek *et al*, 2012). Investments in soil and water conservation (SWC) practices enhance crop production, food security and household income (Adgo *et al*., 2013).

Integrating SWC technologies with the system of agriculture is the issue of sustainability for many countries, whose economy largely depends on agriculture (Antle et al., 2005; Hengesidjisk et al., 2004; Minale et al., 2008 and Fikru, 2009).Recognizing these connections, the government of Ethiopia is promoting SWC technologies for improving agricultural productivity, household food security and rural livelihoods. Particularly in the Ethiopian highlands, different SWC technologies have been promoted among farmers to control erosion.These technologies include stone bunds, soil bunds and *Fanyajuu*bunds (made by digging a trench and moving the soil uphill to form an embankment).However,the adoption ratesof these SWC technologies among farmers vary considerably within the country (Kassie et.al., 2009; Tefera and Sterk, 2010; Tesfaye et.al., 2013; Teshome et al.,2014).

The proper practices of soil conservation, like crop rotation and cultivating windbreak and cover crops, leads to the ability of soil surface to maintain its integrity by reducing both the erosive forces and chemical changes in soil nutrients. Nowadays, soil erosion is considered as one of the most important ecological and economic problems in agricultural and rural communities. Furthermore, soil erosion is one of the most important environmental issues among different kinds of land degradation (Wagayehu, 2003 cited in Ahmad R et.al, 2012)

Over the last four decades, the government of Ethiopia and a consortium of donors have undertaken a massive program of natural resource conservation to reduce environmental degradation, poverty and increase agricultural productivity and food security. However, the adoption rate of SWC measures has been minimal (Bewket, 2007; Tefera and Sterk, 2010; Kassie et al. 2010). In the Amhara region in particular, labor intensive SWC technologies have been promoted among farmers to control erosion and increase production. These technologies include line interventions

such as stone bund, soil bunds, FanyaJuu bunds, and agro-forestry practices.

According to De Graaff *et al.* (2008), there are three phases in the adoption process: the acceptance phase, the actual adoption phase and the final adoption phase. The acceptance phase generally includes the awareness, evaluation and the trial stages and eventually leads to starting investment in certain measures. The actual adoption phase is the stage whereby efforts or investments are made to implement SWC measures on more than a trial basis. The third phase, final adoption, is the stage in which the existing SWC measures are maintained over many years and new ones are introduced on other fields used by the same farmer. The most important reason for limited use of SWC technologies is farmers' low adoption behavior. Kessler (2006) considers SWC measures fully adopted only when their execution is sustained and fully integrated in the household's farming system. According to Tadesse et.al 2004; BoARD, 2010, most farmers have not adopted these technologies and in some cases farmers have disadopted (abandoned) earlier adopted technologies. A better understanding of constraints those condition farmers' adoption behaviors are therefore important for designing promising pro-poor policies that could stimulate and sustain SWC measures adoption and productivity change.

Long-term land sustainability and soil degradation prevention are essential for Ethiopia to feed the growing population of the country (Awdenegest and Holden, 2007).Apart from these scientific evidences, the occurrence of soil erosion in most parts of the country is directly visible. Most cultivated lands in the hills and mountains of the country have suffered from loss of top soil, leaving bare stones. According to this review, varied types of soil and water conservation measures were accepted by most of farmers in highland parts of Ethiopia. But the big problem is related to limited adoption specially sustained use of SWC measures without any incentive.

Recognizing land degradation as a major environmental and socioeconomic problem, the government of Ethiopia has made several interventions. As a result, large areas have been converted to terraces, covered by soil bunds, closed by area closures and planted with millions of tree seedlings. Nevertheless, the achievements have fallen far below expectations. The country still loses a tremendous amount of fertile topsoil, and the threat of land degradation is broadening alarmingly (Teklu et.al, 2015).

Ethiopia is exceptionally high in biodiversity but exceptionally low in capacity for protected area management (Deininger & Jin, 2006). Most of the population is almost completely dependent on natural resources for their livelihoods. Consequently, 97% of the original highland vegetation has already been lost in recent decades due to encroaching agriculture, grazing and settlement by agropastoral communities (Wondieet.al 2011).The local farmers acknowledged the introduced new SWC technologies as effective measures against soil erosion and for improving land productivity. However, the sustainability seemed unlikely. Farmers frequently reject newly introduced soil water conservation practices even when they are aware of the fact that measure protects and improves productivity of the lands. These were related to the personal, socioeconomic and institutional factors with regard to the implementation of the technology as part of the agricultural production systems.

1.1 Objective of the review

a) Main objective

The main aim of this review is to assessAdoption of Soil and Water Conservation Practices among Farmers in Ethiopia: Implication on Factors Affecting Acceptance and ContinuousUse of SWC***Specific Objectives are:***

- To identify factors affecting adoptionbehavior of soil and water conservation practices in Ethiopia
- To assess awareness and attitude of farmers to sustainintroduced SWC practices as their farming system

b) Approach/ Method of Data Collection

The paper is prepared through the following approach

- Reviewing a lot of literatures, reports, documents and proceedings related to the topic under the concern of this review.

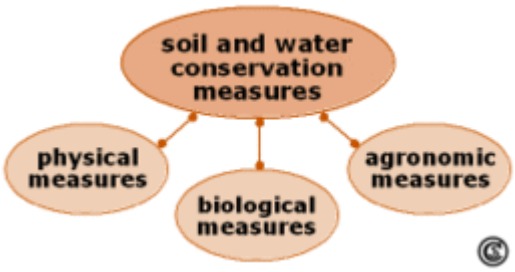
2. Literature Review

2.1 General Concepts and Types of SWC measures

Soil and Water Conservation (SWC) are activities that maintain or enhance the productive capacity of land in areas affected by or prone to soil erosion. The importance of conservation of natural resource for sustainable development is also clearly explained on the Rio declaration of Environment and Development particularly in principle four and eight in such a way that in order to achieve sustainable development environmental protection shall constitute an integral part of development process and cannot be considered in isolation from it. To achieve sustainable development and higher quality of life for all people state should reduce and eliminate unsustainable pattern of production, consumption and promote appropriate demographic policies (UN 1992). Based on the aforementioned ideas from different literature it can be summarized as conservation that refers rational utilization of resource will lead to sustained environment and human development and wellbeing which in turn lead to sustainable development all of which tend towards sustainable human life. Economic sustainability depends on ecological sustainability which depends on the conservation of natural resources (C.A. Perrings et al. 1995)

2.2 Classification of Soil and Water Conservation Measures

A variety of soil and water conservation measures are well known. These technologies can be differentiated either by their main purpose or by type. As many among them fulfil several functions simultaneously these are classified here by type (see figure):



- Physical measures (also termed mechanical or technical measures);
- Biological measures (also termed vegetative measures);
- Agronomic measures (sometimes called best management practices) (Krüger et al. 1997).

2.3 Soil and Water Conservation Practices in Ethiopia

Soil erosion is the major constraints to sustainable agricultural development in Ethiopia. The magnitude and rate of soil erosion continued to increase despite considerable efforts made during the past three decades in conservation activities (Daniel, 2001 cited in Tesfayeand Debebe,2013). Those authors indicated that inKembataTembaro Zone of Ethiopia, soil erosion is the widespread problems that damage the cultivated lands of the farmers. Due to these, farmers have been forced to constantly cultivate new lands by clearing the vegetation in the area. However, soil and water conservation activities promoted by non-governmental organization (NGO's) and government project will be included to prevent soil erosion and environmental degradation. The intention of the projects emphasized on physical soil and water conservation measure like soil bund and *fanyajuu* terracing.

In Ethiopia, since the 1970s, considerable efforts have been made to reverse the problem of land degradation. What were once considered to be sustainable land management practices such as soil and water conservation, soil fertility management, controlled-grazing and other land management practices were introduced. However, the impact of those efforts did not curb the impact of land degradation in a meaningful and sustainable manner. Various reasons are often given for the lack of success. Among these the most commonly cited factors include failure to consider indigenous land management practices, high initial costs which are not affordable to poor farmers and also trying to apply uniform techniques in different agro-ecological regions (Aklilu, 2006 cited in Desta, 2012).

Traditionally through time, farmers have developed different soil conservation and land management practices of their own.With these practices, farmers have been able to sustain their production for centuries. Even up to now, it has been acknowledged that these technologies, which include ploughing of narrow ditches on sloping fields to control run-off,farmland terraces, traditional ditches and furrows, contour ploughing, fallowing, crop rotation, farmyard manure and agro forestrycontinue to play a significant role in the production of subsistence agriculture (Betru, 2003).

In the1980s, the WFP consolidated its support to include rehabilitation of forest, grazing and agricultural lands. On government'spart, the watershed or catchment approach became it key strategy. The major elements of the soil conservation activities werea range of physical structures such as farmland and hillside terracing, cut-off drains and waterways, micro-basins, checkdams, water harvesting structures like ponds and farm dams, spring development, reforestation, area closure and managementand gully rehabilitation (Betru, 2003).

However, efforts made up to the early 2000 were considered inadequate as they covered only 7% of the total land area thatneeded treatment, and at that rate, it was estimated that treating all the remaining land could take seven decades. Evaluationsof efforts made concluded that the interventions were ineffective, insufficient and unsustainable (Woldeamlak, 2003;EEA/EEPRI, 2002 cited in Desta, 2012).

Over the last three decades, the government of Ethiopia and a consortium of donors have invested substantial resources to develop and promote sustainable land management (SLM) practices as part of efforts to improve environmental conditions, ensure sustainable and increased agricultural production, and reduce poverty.

However, due to low rates of adoption, most of the promoted practices have been only partially successful. In some cases, dis-adoption or reduced use of technologies has been reported (Tadesse andBelay, 2004). Past efforts to develop and promote these practices neglected the pronounced regional diversity of the country. For example, the distribution and amount of rainfall vary greatly both in spatial and temporal terms across Ethiopia.

Nevertheless, similar SLM practices such as soil and water conservation technologies (e.g., stone bunds, soil bunds), reduced tillage, and chemical fertilizer have been promoted in all agro-ecologies regardless of their performance under different environmental conditions.

2.4 Factors Affecting Adoption of Soil and Water Conservation Practices

In 2010, the Ethiopian government launched a land restoration program that aimed to double agricultural productivity through improving the management of natural resources and agricultural lands. Following the launch of the program, the regional bureaus of agriculture, district agricultural offices, and otherlocal administrative bodies mobilized farmers to help with the construction of SWC measures. Since 2010, more than 15 million people have contributed free labor equivalent of US$750 million each year. Physical and biological SWC measures have been introduced in morethan 3,000 watersheds managed by local communities. (Mekuria et.al.2015)

The process of accepting andimplementing modern soil and water conservation technologies by the farmers of an area throughexperts and development agents for better land management practices (Yohannes and Herwege,2000 cited in Brahan,2009). Newly introduced SWC measures can be considered as adopted if the farmers continue toutilize them as part of their production system after the external

assistance is withdrawn. Theadoption of a SWC technology can be assessed by analyzing farmers ' attitudes, objectives andaspirations of whether they would like to use the introduced technologies as part of their fanning system (Woldeamlak, 2003 cited incited in Brahan, 2009)

The average annual rate of soil loss in Ethiopia is estimated to be 12 tons/hectare/year, and can be even higher on steep slopes (greater than 300 tons/hectare/year or about 250 mm/year) where vegetation cover is scant(Alemu, 2000).

In the literature on Soil conservation (SC) adoption, the natural physical environment, together with social, economic, and institutional factors are important in determining SC decision-making behavior both in the developed and developing world.

However, the specific socioeconomic and institutional factors affecting decisionmaking behavior may differ between developed and developing countries and different sites within the same region and country, as well as between different farm households (Bekele and Drake, 2003).

Soil and water conservation technologies have not been widely adopted by small holder farmers in Ethiopia or any other countries (Kassie*et al*., 2008). According to the author, in the southern region small holder farmers living in different agro-ecology of the region have not yet adopt the soil and water conservation techniques permanently. The same empirical evidence was reported by findings of Shiferaw and Holden (1998) and Tadesse and Belay (2004) that the rate of adoption of soil and water conservation technologies is low.

A study conducted by Wagayehu (2003cited in Derajew et.al 2013) on soil and water conservation decision behavior of subsistence farmers in the Eastern high lands of Ethiopia, using multinomial log it analysis showed that, plot area and slope, access to information, and project assistance have positive and significant influence on conservation decisions. This study suggest that in promoting SWC technologies to farmers, attention needs to be paid to the agro ecological variations of the farming environment and socio-economic characteristics of the target groups, and the needfor designing and implementing appropriate policies and programs that will influence farmers' behavior towards the introduction of soil and water conservation measures in their agricultural practices.

And also study conducted by Tesfaye (2003), on SWC use in Konso, Wolita and Wello, Ethiopia; indicated that land size, livestock ownership, family size, risk perception, land tenure on non- arable lands, labour organization, characteristics of technology, indigenous institution and physical factors are significant determinants of SWC.

According to the study conducted in SNNPR by Genene et.al, 2014, Negative impacts of incentives and farmers reluctant are very observed factors in continuous use SWC measures. An incentive in the form of cash, kind or both was given for farmers participating in public work through food-for-work schemes. Moreover, the recently launched PSNP has supported food insecure rural families to receive cash or kind payment. They receive incentive for their participation in public work including soil and water conservation. In both cases, when the incentive discontinued farmers are not willing to participate in SWC works. In most places, farmers ask or claim incentives to construct and maintain SWC structures which have negative implications for its sustainability. Farmers are reluctant to maintain the conserved resources and in some cases they have dismantled conservation structures in the absence of incentives.

A study conducted by Yitayal (2004) on determinants of use of soil conservation measures by small holders in Jimmazone, Dedo district, using Tobit model analysis, showed that, slope and distance of the farm plots significantly influencedthe use of both traditional and improved soil conservation measures. Area of cultivated land increased the probability of using improved soil conservation measures especially, improved soil bund and cutoff drain. Farmer's age decreased the use of improved soil conservation structures while education level of head of households has positive impact on soil conservation. Extension education had a substantial contribution to motivate the use of improved soil conservationmeasures but, it had no effect on the use of traditional soil conservations practices.

A study conduct by Million (2001) on factors influencing adoption of soil conservation measures in southern Ethiopia: Gunvno area using binomial logit model showed that farmer's perception of soil erosion problem, technologyattributes, the number of economically active family members, farm size, family size, wealth status of the farmer and thelocation of the farm land are influencing adoption of physical soil conservation measures in the study area.

In the case of SC technology adoption, Mahboubi*et al.* (2005) emphasized that farmers awareness of soil erosion problems was a prerequisite to adoption. Indeed, perception of soil erosion problems is frequently found to positively correlate with the adoption of SC technologies (Bekele and Drake, 2003). Awareness also has something to do with the age of a farmer in influencing adoption. Empirical studies on sustainable land management practices further highlight this complexity. A study conducted in Beressa watershed of Ethiopian Highlands by AkliluAmsalu (2006) identified factors that could influence adoption of different sustainable conservation techniques. This study was done using quantitative and qualitative research methodology and identified farmers' age, farm size, perceptions on technology profitability, slope, livestock size and soil fertility to have an influence in the adoption of stone terraces. It further indicated the decision to continue using the practice was influenced by actual technology profitability, slope, soil fertility, family size, farm size and participation in off-farm work.

Another study by Habtamu (2006) focused on the adoption of physical soil and water conservation structures in Anna watershed of Hadiya Zone, Ethiopia . He also used qualitative and quantitative methodology to identify factors that affect adoption of the introduced soil and water conservation measures to cultivated fields. This study

identified perceptions about soil erosion problem, farmers' attitude to try new technology, participation on conservation training, plan of a farmer to continue in farming career in the following five years and farmers' perception about effectiveness of the technology in arresting soil erosion to have significant positive influence on farmers' decision to retain conservation structures. Farmers' contact with development agents, educational attainment of the household head and land tenure security were identified to have weak and positive influence on the farmers' decision to retain the introduced structures. Age of the household head and land holding size were identified to have significant negative influence, whereas variables such as livestock holding, off-farm employment and distance from farm plots were identified to have weak negative influence.

Also According to Waga et.al 2013, the factors influencing adoption of physical soil conservation measures around Gununo watershed area in SNNPR include farmers" perception of erosion problem, technology attributes, the number of economically active family members, farm size, family size, wealth status of the farmers and the location of the farm land (Tadesse and Belay, 2004 cited in waga et.al 2013).

A case study conducted by Mushir et.al, 2012 also revealed that the major problems related to conservation structures mentioned by the respondents in SNNPR include, source of pests, inconveniency during ox ploughing, reduction of farmland, labour intensiveness, difficulty in implementation, and costliness.

2.5 Awareness and Attitude of Farmers to Sustain Improved SWC Practices

Since human destruction on the environment partly arise from their attitudes towards the environment, fundamental changes in people's ways of thinking and behaving should get priority to bring significant changes in conservation (Barraza and Pineda 2003)

People's attitudes, perceptions, whether narrow or broad in scope shape the atmospheres on which environmental struggle are resolved. Therefore, understanding how people consider and perceive environmental issues is one of the areas needed in policy formulation with regard to environmental issues. The farmer's use of his resource will depend on his perception of them rather than any objective measure of their characteristics. His perception of their value for alternative production systems will depend of his background, information and ability and his yardstick will be based on his past experience of them. The ability of farmers to adopt soil conservation measures will depend on their access to all appropriate resources. These may vary from access to knowledge of new systems to an ability to afford the necessary inputs of capital to take them up. The numbers of extension workers with experience of soil conservation, the access of the farmers to extension staff and the perceived relevance whether an extension service is successful or ineffective (Genene et.al, 2014).

The various perceptions of farmers towards SWC measures such as reduction in the size of cultivable land due to the physical SWC structures, harboring rodents, labor-intensive nature etc., had created challenges in the adoption and sustainability of SWC measures, whereas farmers with less livestock, on steep slopes and with poor fertility implemented the practices better than those experiencing contrasting situations (Mahesh et.al, 2018).

Asnake and Hans 2015 in their study in the highlands of Ethiopia revealed that clear understanding of the benefits of environmental management by farmers is found to be main factor in the success of environmental management efforts. Therefore, changes in the attitudes of farmers through field visits are necessary steps for the adoption of environmental management measures throughout the Ethiopian Highlands.

Study conducted in Gulisoworeda, Western Wellega Zonepractices indicated that some controversial attitude among farmers towards SWC practices. The finding revealed that 68% of the respondents argue that resource management should mainly be the responsibility of the government rather than the local community. In other case some farmers have an attitude that everyone is responsible for the problem but not only the responsibility government.As the farmers have lack of knowledge, lack of awareness, lack of training, financial problem the government should implement policies and programs about soil conservation strategies. Generally creating awareness about soil conservation and training the farmers about land degradation and land management practices will is solve the problem of land degradation.

The study conducted in Laelay maychew wereda, tigray, Ethiopia indicated that the soil conservation is usually done on the communal land. Out of this compulsory soil conservation practices, most people participate in soil conservation activities under Safety-net. The Safety net is usually given to those poor people aiming dual benefits one recovering the environment and secondly taking out peoples out of poverty. In addition to the safety net, food for work is also practiced in the wereda. Food for work has no limitation to any body and hence everybody can partake in conservation and get payment of that.

The review conducted in SNNPR in Ethiopia by Geneneand Abiy, 2014 also revealed that difference in perception of farmers**:** farmers perceive SWC techniques differently. Resource poor farmers do not appreciate the real fertility status of their farmlands and give low priority to soil conservation measures; rather they give high emphasis for annual farming. Poor farmers concentrate on day to day farming activities to fulfill the daily food requirement of their family. They have low perceptions about the impacts and socio-economic and environmental benefits of soil and water conservation measures. In contrary, wealthier farmers perceive better and aware of the severity of the land degradation and invest on soil and water conservation practices to halt soil degradation. Less training on natural resource management**:** there is less or no subsequent training on natural resource management, specifically on soil and water conservation measures. There is no formal and informal type of training given to farmers to raise their awareness and perception level of natural resource management. The capacity building targeting natural

resource management is rare, rather more attention has be given to crop and animal production.

The study conducted by Tesfaye et.al 2013 in Adama*Wereda*, East Shewa, Ethiopia some farmers use both traditional and improved SWC measures. The majority of the farmers removed the introduced SWC technologies totally. This result indicated that almost (88% and 64%) of the respondents removed totally and partially the newly introduced SWC technologies in the area. They believed that the conservation technologies introduced were not productive as or less productive than traditional conservation structures.

Another very important misunderstanding, not only among policy makers but also among many practitioners, is that soil and water conservation (SWC) measures are a panacea for land degradation. The integration of different sustainable land management practices and technologies to make SWC measures more effective and enhance soil productivity is seldom considered (MoARD, 2007).

3. Conclusions

Land degradation and deterioration of agricultural productivity aremajor threats to current and future livelihoods of farm households inEthiopia. Of the complex environmental problems Ethiopia faces today,soil erosion and deforestation remain the most serious.Therefore, adoption of different soil and water conservation practices will be imperative in order to combat this problem. This in mind, this review basically tried to identify the major determinants of adoption of SWC practices in Ethiopia and assessed the awareness and attitude of farmers to sustain improved SWC practices.

Based on the results of the review, soil erosion is considered as one of the most important ecological and economic problems in agricultural and rural communities. Furthermore, soil erosion, either natural or induced by human, is a continuous process which various aspects of human behavior can partly affect degradation of soil. Hence, the success of soil conservation programs needs the knowledge about the different aspects of factors.

The adoption of SWC practices is multidimensional with numerous factors affecting the willingness of farmers to use various conservation practices. The effects of most socio-economic variables on the adoption of land management practices have not been conclusive and have been noted to vary with location given the divergent reports available from existing literature.

To ensure sustainable adoption of SWC and beneficial impacts on productivity and other outcomes, continuous encouragement and empowerment of farmers on SLM practices as well as rigorous empirical research is needed on where particular interventions are likely to be successful. This information would assist policymakers and development practitioners in their efforts to reduce poverty and promote natural resource management strategies.

4. Recommendations

Based on the review result, the following recommendations are forwarded:

1) Training and promoting the perception and awareness of farmers about the effect of soil erosion on the whole lands as well as natural resource conservation should be consolidated.
2) Improving theexisting indigenous knowledge system of soil conservation and the possibility of integration between indigenous knowledge systems with some modern/scientific SWC systems should be strengthened
3) Strong rules and regulations that govern farmers to protect natural resources, uncontrolled grazing and deforestation could be given more emphasis.
4) Examination of the determinants for adopting the SWC systems and improving the scale of adoption of SWC practices through rigorous researchand support from concerned bodies will assist in bringing down the scale of the problems and ensure the widespread adoption of them.
5) To ensure sustained use of introduced SWC measures continuous follow-up and encouragement from government and other supporting bodies for farmers should be strengthened.

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