Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.4, No.7, 2014

Review on Overall Status of Soil and Water Conservation System and Its Constraints in Different Agro Ecology of Southern Ethiopia

Genene Tsegaye Mekonnen[1*], Abiy G/michael[2]
1.Researcher, Hawassa Agricultural Research Center, SARI, P.o. Box 06, Ethiopia
2.Researcher, Bonga Agricultural Research Center, SARI, Ethiopia
Email address: genenetseg@gmail.com

Abstract
Soil erosion is one of the major challenges of Ethiopia deteriorating the productivity of land. Soil and water conservation is the only practice to reverse the threat and protect the land. Over the last three decades, different soil and water conservation activities have been undertaken. However, soil erosion still persists and become major threats of the southern regional state. This study was conducted to assess and identify major constraints existing in soil and water conservation system of the region. Lack of integrated bio-physical measures, absence of integrating indigenous practices, negative impacts of incentives, lack of considering socio-economic profile, low perception and participation of farmers, poor conservation design, mis land use, less maintenance, weak monitoring and evaluation of soil and water conservation are the major constraints exist in midlands. Synonymously, low perception, less involvement of farmers and open grazing are the dominate constraints in lowlands. Moreover, low interest of farmers, land use change and less treatment of gully areas are major constraints at highland agro-ecology. The findings recommended that use of agronomic and integrated soil conservation measures, subsidy of agricultural inputs, efficient use of incentives, socio-economic considerations, use of effective approach in mobilizing community, adoption and dissemination of best technologies, integrating indigenous practices and policy issues should be considered in implementing soil and water conservation. In conclusion, to reduce soil erosion sustainably, different soil and water conservation options should be introduced and used considering agro ecology, socio-economic profile and climatic condition of the intervention area.
Keywords: Soil and water conservation; Agro-ecology; Soil erosion; South Ethiopia

1. Introduction

Natural resource degradation in general and soil erosion in particular is the major challenges of the South Nation Nationalities Peoples' Region (SNNPR). Unwise management and use of natural resources is one of the major socio-economic and environmental factors that has caused low crop yield in SNNPR. Among the natural resources; land, soil, forest and water are the major dominant ones which plays a vital role on food security status of households. On the other hand, the dependency of livelihoods of majority of the rural people on agriculture contributes to the increasing deterioration and destruction of the natural resource base. The potential of the land or its productivity has deteriorated from time to time due to run off, topographic variations, slope of the land, intensive cultivation, farming on steep slopes and deforestation.

The productive land, in Ethiopia in general and in SNNPR in particular has been seriously threatened by land degradation, threatening both the economic and survival of the people. Land degradation is a severe problem that contributes to low agricultural productivity, which aggravates food security problems. It includes soil erosion, soil nutrient depletion, salinity and changes in soil structure. Among the various forms of land degradation, soil erosion is the most serious problem, which results in soil nutrient depletion and loss of productive capacity of land. Soil erosion is the process of detachment of soil particles from the top soil and transportation of the detached soil particles by wind and/or water (Panda, 2007). Soil erosion is environmental problem, which poses an ominous threat to the food security status of population and future development prospects of the country (Wagayehu, 2005). Water, wind and livestock are the main agents and causes of soil erosion in SNNPR as elsewhere in the country.

Soil conservation is the only known way to protect the productive land (Panda, 2007). Conservation of soil resource is a significant socio environmental issue that affects the well being of people in every country in the world. It increases crop yield and prevents further deterioration of land. On the other hand, the failure of farmers to adopt soil conservation practices has contributed to the degradation of a significant portion of agricultural land. The Soil Conservation Research Project (SCRP) has estimated soil loss of which 1.5 billion tons of soil has been eroded every year from Ethiopia (Kruger *et al.,* 1997).

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. In spite of the efforts attempted in the country, it remains widespread and the treats become expanding. In some parts of the country, the problem of environmental degradation has gone beyond all limits of reversal and is expanding very fast. The attempt made to alleviate the problem was not fully based on the agro-ecological, socio economic and topographic variability of the region, hence, there should not be a blanket recommendation of a single or some conservation measures and biological stabilizer to all agro-ecological, topographic and socio-economic set ups (Hurni, 1995).

Over the last three decades, different soil and water conservation (SWC) activities have been undertaken throughout the country including the southern region by government and World Food Programme (WFP) under the food for work (FFW) schemes. Currently, in more than 79 districts of the region, different physical and biological SWC measures are implemented by community through Productive Safte Net Program (PSNP). Moreover, the government has devised green economy strategy like community based integrated watershed management all over the country to rehabilitate severely degrades land and then to maintain the natural resource base. On the other way, different land enhancing technologies and practices have been introduced and disseminated by research institutions, extension and other development practitioners in the region. However, soil erosion problem still persists and become major threats for the eco-system and causes for food insecurity vulnerability of people. Thus, this study was conducted to assess and identify major constraints and challenges existing in SWC system of the region and ultimately recommending strategies for sustainable soil and water conservation intervention so as to halt soil erosion and improve agricultural productivity in Southern regional state of Ethiopia.

2. Research Methodology

2.1. Geographical and socio - economic description of the study area

The Southern Nations, Nationalities and Peoples' Region (SNNPR) is one of the nine regional states of Ethiopia located in the south and south-western part. Geographically it is situated between the coordinates of 4^0 27' and 8^0 30'N and 34^0 21' and 39^0 11' E with altitude ranging from 376 to 4207 m asl and with mean annual temperature ranging from 15^0c to 30^0c (BoSP, 2004). It covers approximately a total area of 110931.9 km^2 divided into 14 administrative zones and 136 districts. It has very diverse agro-ecology classified as lowlands, mid and highlands covering 57.4, 34 and 8.6% respectively. SNNPR has 13 major and 19 sub-agro-ecological zones (IFPRI, 2006). Rainfall pattern of the region is bimodal with small rain in dry season and high rainfall in main rain season with mean annual rainfall ranging between 400 mm in the extreme south of *Debub Omo* zone and over 2200 mm in the west in Sheka and Kaffa zones. SNNPR has a total population of 15.04 million of which 89.72% of the people are living in rural areas and 10.28% are urban dwellers (CSA, 2008). The population density ranges from 4 to 900 persons per square kilometer. The average land holding size of the region is estimated to be 0.75 ha which lies below the national average (1.2 ha) (CSA, 2010). The region has typical ethnical cultural diversity comprising more than 56 distinct nationalities living in different agro-ecology all having their own culture, farming system, indigenous knowledge of managing natural resources.

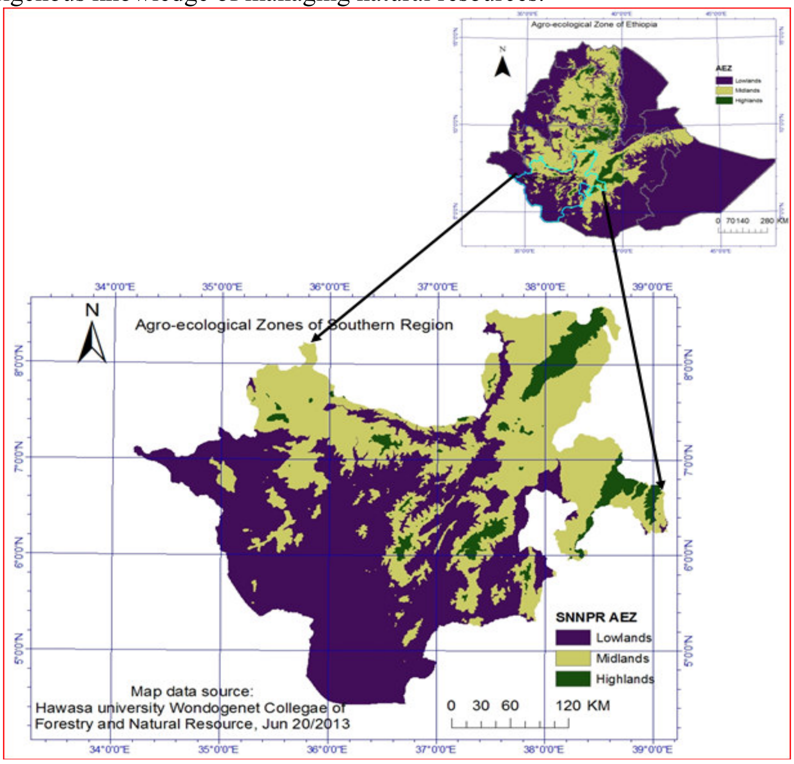

Figure 1: Map of the study area with three Major Agro-ecologies

2.2. Data type and collection methods

Qualitative data were collected using focus group discussion (FGD) and key informants interview. FGD was carried out with farmers practicing different SWC practices on their farm and communal land. FGD was focused on opinions of farmers on trend, status, challenges and constraints of SWC interventions in their locality. Apart from FGD, structured observation was done on type of SWC practices, prevalence and extent of soil erosion, type and applicability of design and structure of SWC practices, severity and effects of soil erosion, maintenance and sustainability of soil conservation structures. Moreover, socio-economic and environmental indicators of SWC such as crop yield, crop choice, forage availability, tree species type, forest and vegetation cover, water availability and the farming system was observed.

Beside FGD, in-depth interview with key informants working on SWC, forestry and agro forestry was carried out. Types of indigenous and introduced SWC activities, farmers' copping strategies to soil erosion, trends of SWC practices, major constraints of SWC, role and involvement of gender in soil and water conservation interventions, policy issues focusing on incentives, sustainability in relation to soil conservation practices, lessons learnt in implementing SWC were discussed. More importantly, articles and reports were critically reviewed giving emphasis to the prevailing social, economical, environmental and institutional constraints of SWC practices in three main agro-ecology of SNNPRs.

3. Literature Review

3.1. Conceptual aspects of soil and water conservation measures

The south region is endowed with high potential of land and water resources. These resources have to be used in sustainable way in day to day life of the citizens with exposing it to little or no damage while guaranteeing their continuous usage. Contingent the facts, there are different human interventions that expose the natural resource assets to continuous depletion and loss. Among these, agricultural mismanagement of soil and water resources: clearing of forests, removal of crop residues, improper crop rotation, overgrazing, use of marginal land, poor soil management, weak adoption and/or inadequate soil and water conservation practices are the major environmental constraints and threats for the sustainability of land and water resources.

There are different socio-economic and institutional causes for the depletion of the natural asset. Population increase, land shortage, insecure land tenure, poverty and economic pressure are the major causes of mismanagement of the natural resources (FAO, 2001). Population growth has long been considered a prime cause of environmental degradation (Atakilite, 2003). It forces farmers to cultivate marginal, steep slope and forest land. But in some areas of the world, there are optimistic views that high population growth could not lead environmental degradation, for example the Kenyan Machakos district (Atakilite, 2003). Though there are controversial arguments concerning population growth, different studies (FAO, 2001; Pender *et al*., 2004) have shown that in sub-Saharan African countries including Ethiopia has supported the Malthusian classical thought of population growth i.e. "more people-high erosion" has shown a cause to soil degradation.

A study made in north western Ethiopian highlands by Gete (2000) reported that the absence of sound land use tenure policy, population pressure, weak economic development strategies, unstable institutional frame works and weak link between research and extension have found to be root causes of soil degradation and are major policy constraints discouraging farmers from making any sort of investments in the land. Factors like land tenure, size of farm holdings, availability of credits, use of farm inputs, effectiveness of agricultural extension service, farmers' awareness of technologies, farmers' ability to afford and apply technologies and overall agricultural infrastructure contribute significantly to the achievement of sustainable land use (Ayalneh, 2002).

The natural resource management extension service and promotion is provided by extension workers and to some extent by non-governmental organizations. As elsewhere in the country, In SNNPR, three to four development agents have been assigned at each *keble*[1] to give frequent technical support and advice to farmers. Moreover, the development agents are in place to demonstrate and disseminate natural resource management technologies. However, the adoption of SWC practices are low and even the adopted are not utilized in sustainable manner. In some areas farmers are reluctant to manage the conserved resources, and even some farmers have removed or dismantled conservation technologies and practices in the absence of incentives like food-for-work or cash-for-work. There are evidences that witnessed SWC structures after some time are partially or totally removed (Shiferaw and Holden, 1998; Tadesse and Belay, 2004).

3.2. Historical background of soil and water conservation in SNNPRs

Soil and water conservation is a key issue in Ethiopian economy in general and in southern Ethiopia in particular where there is high population pressure and land fragmentation. To reduce and /or to reverse land degradation in general and soil erosion in particular, different soil and water conservation measures have implemented throughout the country. Until the introduction of improved soil and water conservation technologies and practices in the early 1970s, no emphasis was given to soil and water conservation techniques. Little has been

[1] *Kebele* is the current naming for the lower administrative level of the country, it is equivalent to peasant association (PA).

done in areas of conservation extension including natural resource management. However, for centuries, farmers have been using different indigenous soil and water conservation measures like physical conservation structure, agronomic conservation and traditional fallowing to reduce soil erosion, to increase soil fertility and to maintain the eco-system of the environment.

After the outbreak of famine in Ethiopia in 1973, different SWC techniques were introduced to different parts of the country including the southern region by government and non-government organizations. In Ethiopia, the first food –for- work (FFW) supported SWC activities was started in 1971 in Tigray and in 1972 in Wello with U.S food under PL 480 project to carry out reforestation and construction of low cost rural roads and small water projects (Hurni 1988; cited in Tesfaye 2003). These activities were replaced by FFW projects funded by World Food Programme (WFP) in 1974. Under FFW, there was massive public soil conservation working on degraded and hill side land on drought-prone areas of the country. During that time about 15% of Ethiopian degraded highland was covered by soil and water conservation structures (Hurni 1988; cited in Tesfaye 2003). Similarly, on highland parts of the country, about 600 km of earth and stone bunds was constructed on cultivated lands, 300000 km hillside bunds were built for the afforestation of steep slopes and thousands of tree seedlings were raised in nurseries and transplanted on afforestation sites (Ibid). In addition, about 980000 ha of crop land were treated with various types of terraces, 310000 ha of degraded and 100000 ha of hilly land were enclosed, 296000 ha of highly denuded land were re-vegetated and 280000 ha of hillside terraces were constructed (Kruger *et al*., 1997).

Currently, to reverse the threats of climate change caused by deforestation, soil erosion and soil fertility decline, massive public interventions in areas of soil and water conservation has been launched by the Ministry of Agriculture (MoA) since 2011. In this program, community based integrated watershed management approach is chosen as 'green economy strategy' to mobilize community in planning and constructing different integrated SWC at their locality both on communal and private land. In southern region, similar watershed development interventions have been implemented primarily for an objective of reversing land productivity threat and maintaining the diverse nature of the environment and eco-system of the area.

3.3. Soil and water conservation constraints in southern region

Introduced soil and water conservation techniques have been implemented by government organization particularly by the regional Bureau of Agriculture, starting from region to district level. Moreover, various non-governmental organizations including bilateral and multi -lateral organizations have implemented soil and water conservation techniques in the highly degraded areas to halt the rapidly increasing land degradation specifically soil erosion. Apart from the exotic soil and water conservation techniques, indigenous soil and water conservation activities have been implemented by individual farmers for the aim of mitigating soil erosion, conserving soil moisture and increasing soil fertility at household farm level. Nevertheless, land degradation and soil erosion is still a serious environmental and socio-economic threats of the region. Starting from the down fall of the Derg[2] regime, scholars have identified different socio-political, institutional and environmental factors why the problem still persists and become a crucial challenges to the region. Some of the important findings are summarized as follows:

A Soil Conservation Research Program in Ethiopia highlighted that, following the 1973-74 famine, with the heavy external support, the government of Ethiopia has launched exotic SWC techniques to be implemented in the highland parts of the country including the highlands of the southern region. During this period, very severely degraded land was covered by different types of soil and water conservation structures and enclosed for natural vegetation regeneration. The efforts induced were scattered and little have been achieved to protect the productive land in sustainable manner. Efforts made to mitigate land degradation problems and boosting agricultural production is losing an incredible amount of precious top soil annually (Kruger *et al*., 1997). The two main reasons given for the failure of introduced soil and water conservation techniques were: firstly poor record of indigenous knowledge attributed to lack of appreciation for indigenous soil and water conservation practices and secondly Ethiopian farmers have been traditionally conservation minded at the scale of their farm operation. They have long been aware of the problem associated with soil degradation, but all the indigenous knowledge, conventional and/or traditional methods of soil and water conservation techniques of the farmers were not integrated to the modern techniques of SWC in each stages of planning and implementation (Ibid).

A soil Conservation Research Project (SCRP) that was financed by the Swiss government was actively operated from 1982 to 1995 at Gununo, Walaita. An impact study done by Tesfaye (2003) on farmers' SWC practices reported that farmers in the area had adequate knowledge and understanding of erosion process and its negative consequences. In spite of farmers' appreciation and understanding of soil erosion, there was an increasing non-acceptance of SWC structure namely soil bunds introduced by SCRP through food-for-work. Lack of farmers participation in problem identification, planning, further decision making process, use of food-for-work as an

[2] derg is the past Ethiopian government regime lasted from 1974 to 1991.

incentive without considering the socio-economic characteristics of farmers were the main reasons for non-adoption of SWC.

Perception of farmers' to land degradation and soil erosion is a crucial factor for farmers to apply SWC techniques. A study made by Genene and Wagayehu (2010) at Bilate watershed, Southern Ethiopia reported that a higher number of farmers, i.e., 84% and 85% of the cases perceived the presence of land degradation and soil erosion in their farm fields respectively. However, most farmers did not practice technically sound soil and water conservation activities due to social, economical, environmental and political factors. Some of the major factors reported were:

> "Land size: it is closely associated with soil fertility and soil erosion perception of farmers thus farmers with large farm holding perceive soil erosion better than those with smaller one. They practice traditional fallowing and also allot enough plot of grazing land for their cattle that help to mitigate soil erosion and fertility depletion.
>
> Method of land preparation: it affects perception of farmers' that higher soil erosion was observed on farm fields where improper farming practices are common. Cultivating steep soils, burning crop residues, clearing bushes and vegetation, use animal power for cultivating land on steep slope are some of improper farming practices that speed up soil erosion.
>
> Education and wealth: are important socio-economic factors influencing farmers' perception of land degradation, in that educated farmers are always in a better position to adopt and apply soil conservation technologies so as to halt soil erosion. Moreover, adopters of soil conservation technology are strongly and positively associated with wealth status of farmers.
>
> Land tenure arrangement: is a very important factor that influences farmers' decision to invest on soil and water conservation techniques. Similar to other areas, in *Bilate* watershed, farmers have the right to own farm land and they can either use or rent out their land to relatives or neighbor farmers on cash basis. Rrental land is more likely to be degraded, hence there is no or little soil and water conservation investment on land rented out to others."

In the highland parts of the southern Ethiopia there is low soil fertility mainly caused by soil erosion. To tackle low soil fertility, a collective action (CA) type of soil and water conservation practices was initiated around Wolaita area, at Gununo watershed having a total area of 544 ha (Waga *et al.*, 2007). In the CA all the process of soil and water conservation was leaded by local institutions selected by farmers and farmers living in the watershed area were participating in all phases of the chosen intervention (level *fanya-juu* 66.9%, soil bund 30.5%, cut off drain 2.6% and biological stabilizers) for two consecutive years (Ibid). The authors identified the following challenges and constraints while implementing CA at Gununo watershed:

> "First, at the planning stage farmers were reluctant to the CA, due to they have an experience of food aid incentive for SWC work. Secondly they request farm implements to dig and excavate terraces and thirdly difficulty of allocating working days emerged due to the newly introduced approach of helping food insecure farmers through Productive Safety Net Program (PSNP). After looking PSNP, farmers raised the question of food incentive which makes CA difficult to continue. Moreover, poor quality of SWC works, poor coordination of the local leaders and involuntariness of individual farmers to maintain structures were some of the challenges in implementing CA. All the challenges faced were solved with discussion, negotiation and by empowering farmers in all decision making process.''

The konso people, are well known by their indigenous agricultural system of integrated soil and water conservation measures. It include: stone terraces, tied ridges, thrash lines, agroforestry, intercropping, manuring, kraal shifting, burning of debris and minimum tillage (Tesfaye, 2003). This integrated soil and water conservation measures are the uniqueness of Konso agriculture specifically they are well known by a stone terrace- based integrated SWC system. In spite of such unique and exemplary indigenous conservation measures, it has begun to show sign of deterioration because of unfavorable internal and external driving forces (Ibid). The author revealed that the collapse of population control methods due to disintegration of the indigenous population controlling mechanisms, integration in to wider markets and institutions to search for alternative income sources, microclimate change resulted in drought and yields decrease, makes difficulty of soil and water conservation structure maintenance as before.

Soil and water conservation technologies have not been widely adopted by small holder farmers in Ethiopia or any other countries (Kassie *et al*., 2008). The southern region is not an exceptional that 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. Tadesse and Belay (2004) further pointed out, heterogeneity of household socio-economic characteristics, land holding or farm size, institutional patterns and technology specific traits are important factors to be considered in designing and implementing physical soil and water conservation measures.

Implementing physical SWC measures without biological stabilizers could not be a measure to reduce soil erosion. As reorted by Kassie *et al* (2008), in high rainfall areas of Ethiopian highlands *fanya juu* bunds was implemented without associating with fodder grass production on bunds. unless productivity is increased by increasing fodder production on bunds, *fanya juu* bunds alone could not be characterized as ''a win-win'' measures to reduce soil erosion (Ibid).

4. Soil and Water Conservation Constraints

The southern region has diverse agro-ecological conditions ranging from hot arid to tropical humid types of agro climate. The majority of the regions' people are inhabited in mid and highlands climatic zones. Only 25% of the total population is living in low lands parts of the region while 75% are living in mid to highlands parts of the region. The dominance of agriculture as main economic activity become the main causes for the depletion and deterioration of natural resources. More importantly, the soil which is the main source of smallholder farmers' livelihood has been exposed to vast and accelerated type of physical, chemical and biological degradation. The major soil and water conservation constraints differ from agro-ecology to agro-ecology, depending on socio-economic, farming and pastoral system and environmental characteristics of the area.

4.1. Constraints of SWC at mid-lands (*woina dega)* agro-ecology

Midlands agro ecology is the intermediate climatic zone of SNNPR that has a tropical sub-humid warm climate lies between the ranges of 1500 to 2500 m asl. It covers 34% of the total landmass of the region and it is moderately suitable for settlement and agricultural activity. It mainly includes the northern (Gurage, Hadiya, Kembata Tembaro, Yem), centeral (Gamo Gofa, Walaita, Sidama, Gedio and Dawuro) and the north west zones (Kafa, Bench Maji and Shaka). As the major agricultural activities of the region has took place here, it is also known by its soil erosion. In reversing and mitigating such vast and accelerated environmental hazards, there exist immense soil and water conservation constraints. The major constraints are summarized as follows:

Poor or lack of integrated bio-physical soil and water conservation measures**:** the physical soil and water conservation structures have been poorly or partially supported with biological stabilizers like fodder trees, multi-purpose trees, live bund stabilizers. In most of the areas, soil and water conservation practices have been done either with food-for-aid schemes or government campaign through different programs. In some areas farmers tried to use soil and water conservation practices on their farmland. In spite of the effort to construct different physical soil conservation structures both on communal and private farm land, in most cases it was not supported with biological soil and water conservation measures.

Absence of integrating indigenous SWC**:** for centuries, Ethiopian farmers have indigenous and traditional knowledge and skills to manage their farm land. In Southern Ethiopia there are ample indigenous soil and water conservation techniques that enable farmers to manage and use their land. Farmers have typical agronomic soil and water conservation practices to conserve the soil, moisture and to enrich soil fertility. Some of the known agronomic practice are: crop rotation, contour ploughing, mulching, manuring, strip cropping, agro-forestry practices and life tree planting. The failure to integrate these rich practices to exotic soil and water conservation is one of the main constraints exist in *woina- dega* and *dega* agro-ecological zones.

High population growth and density**:** as the *woina-dega* climatic zone is suitable for settlement and agricultural practices; there is high population density. High population density forced majority of farmers to depend on intensive farming for their subsitence which is a prime cause for less or no attentioin towards longterm soil and water conservation investement. The Malthusian calssical thought i.e., ''more people high erosion'' holds true in the mid to highland areas of the region. As a result of reduced size of land holding, both landowner and landless try to cultivate bush and forest land, marginal land, steep slopes and mountaneous areas and resulted in the topsoil to be washed away easily. Hence, people are forced to incline towards their immediate livelihood need rtaher than investing on SWC that posed a win-win negative impacts on soil and climate.

Negative impacts of incentives**:** following the Ethiopian famine, there was huge foreign government support program of soil and water conservation 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 strucures which has negative implications for its sustainablity. Farmers are reluctant to maintain the conserved resources and in some cases they have dismantled conservation structures in the absence of incentives. This observation is supported with evidences that when incentives stopped, beneficiary farmers dismantled and/or abolished the constructed soil conservation works from communal and private land (Shiferaw and Holden, 1998; Gete, 2000).

No or less participation of farmers: most of the interventions of soil and water conservation practices have either not fully or partially considered the involvement of farmers. Problem identification, planning, design, monitoring and evaluation of introduced soil and water conservation techniques have been done separately with subject area specialists, experts and in some cases with consultants. Farmers were forced to implement the introduced SWC interventions mainly with top down approach with full of enforcement. Failure to participate community at all stages brought less ownership sense to soil and water conservation structures constructed in the area that imposed negative impacts to its sustainability.

Lack of considering socio-economic and cultural condition of farmers**:** in implementing soil and water conservation activities consideration of heterogeneous household characteristics, asset ownership, technology specific traits vis-vis farming systems, culture of people, local ecology and institutional arrangements are of paramount importance for adopting and applying soil and water conservation techniques. The failure of considering the socio-economic and cultural status of farmers has been one of the constraints to the sustainability of SWC practices in the region.

Absence of efficient natural resource extension system**:** inefficient extension system, weak link between research and extension are root causes of un wise utilization and management of the natural resources. The development agents have been assigned to support and advice farmers in all agricultural activities including SWC. However, the adoption of natural resource management technologies are low and even the adopted ones are not sustainable. Gete (2000) reported that unstable institutional frame works and weak link between research and extension have found to be root causes of soil degradation and are major policy constraints discourage farmers from making any sort of investment in the land to use it in a more suitable way.

Difference in perception of farmers**:** farmers percive SWC techniques differently. Resource poor farmers do not apperciate 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.

*Mis land use***:** weak or less adoption of soil and water consrvcation techniques, cultivating marginal, hilly and mountaneous land, improper use of agronomic practices, clearing of forest and bushey areas expose the top fertile soil to erosion and depletion of its nutrient. Such mis land use in the region has imposed its negative imapcts on sustained soil and water conservation practices.

Poor SWC design and treatment: most of soil and water conservation practices implemented were not following proper survey and standard design. For example, there is low or no consideration of socio-economic profile of the area, less attention to the orientaion and slope of the land, improper palcement of SWC treatments, wrong combination and application of design are the major design problems contribute to inefficient SWC practices.

Low or no maintenance: in most parts of the region thousands of SWC structures have been constructed by food-for-work and free public labour. Different teraccing for example soil and stone bund, micro and ibro basin, fanya juu, trunch bunds, check dams, graded bunds, etc have constructed at communal and private land. However, in most cases, farmers are reluctant in mainatining the structures, particularly those constructed in communal lands. Structures constructed in communal lands are fully destroyed, cultivated and opened to free grazing.

Weak monitoring and evaluation: to ensure the sustainability of soil and water conservation measure, monitoring and evaluation is mandatory. In this regard, there is weak technical support and follow up of SWC activities from all sides. All stakeholders are not fully participating in monitoring and evaluation of SWC activities at their locality. There is no standard toolkit developed to monitor and evaluate SWC interventions. Different soil and water conservation practices have been done, nonetheless, the status, lessons, impacts and their social dimensions have not been fully evaluated and documented.

4.2. Constraints of SWC in lowlands (*kola*) agro-ecology

Hot lowlands (*Kolla*) agro-ecology is the major agro-ecology that covers 56% landmass and inhibited by 25% of the total population of the region (BoSP,2004). It is located below 1500 m asl with hot arid and semi-arid climate having relatively high temperature and low rainfall. The *kola* agro-ecology covers the southern and south-west moist parts of South Omo and Bench-Maji zones. These climatic zones are known by agro-pastoral way of livelihood with livestock and lowland sorghum and maize production. Even though, there is less agricultural practice of crop production, high land degradation mainly deforestation and soil erosion is predominantly exist.

Low perception of SWC problems: local people at low land areas have low perceptions of SWC problems. The awareness, concern and attitude of farmers and agro-pastoralists on various forms of land degradation in their locality is low. Severe gully formation, low absorption capacity of soil, formation of termite mounds, low ground water recharge capacity, low vegetation cover, disappearance of grass, emergence of invasive weeds and crop

yield decline are some of the important indicators for low perception of SWC problems in the low land agro-ecology of the region. Moreover, farmers have less awareness on the problem of soil erosion because most of them have wide land holding and they give low emphasis to conservation practices.
Inadequate involvement of the local people: similar to mid agro ecology, local people are not fully participated in identifying, understanding and implementing SWC measures. The 'classic approach' the top-down approach to SWC measures have been implemented in a dismissive manner. In this approach the local indigenous and traditional approach was not incorporated with introduced SWC techniques which led to low sustainability of SWC structures.
Free and overgrazing**:** the low land agro ecology of SNNPR is dominated by livestock farming system, where large herds of cattle and shoats are reared at a larger scale. Overgrazing is one of the main causes of land degradation exposing the top fertile soils to be eroded easily. Pastoralists and farmers whose livelihood is majorly depends on animals farming, have low perception and attitude towards SWC measures which imposes negative impacts to implement it.
Charcoal extraction**:** the low lands of SNNPRs are well known by its bush, woodlands and scattered forests. Both the semi-pastoralists and farmers living in and near there spent much of their time on charcoal extraction to supply to urban centers and travelers. Charcoal making has impacts on socio-economic and ecology of the area. A big biomass potential particularly preferred acacia species, road side public forest, private forest and bush lands have been highly deforested for the extraction of charcoal which exposes the soil to high erosion and nutrient depletion. Inhabitants whose livelihood is depending on charcoal have two impacts on soil and water conservation activities. First, they have no time to work on SWC interventions and secondly the business 'charcoal extraction' by itself speeds up land degradation through deforestation which makes soil and water conservation investment expensive and difficult.

4.3. Constraints of SWC in highlands (*Dega*) agro-ecology

This agro-ecology has an elevation range of 2500 to 3000 m asl where wheat, barley and faba bean are the most growing agricultural products. Although the area is characterized by heavy rainfall, yet the concentration of precipitation is primarily limited to few months from May to September. Due to hilly topography most of the rain water is wasted as runoff and lot of soil erosion also occurs as the land is being cultivated in this period. The indigenous techniques of SWC developed in highland agro-ecology of the region are fallowing, shifting cultivation, crop rotation and leaving crop residue on farm. Some of the important constraints of SWC measures are:
Low interest of farmers to SWC measures: farmers living in highland areas of the region have low land holding. In some districts of the region, some farmers have less than 0.25 ha of land that challenged them to apply soil and water conservation measures on their limited farm land.
Land use change: escalating population increase coupled with high food per capita requirement of the highland areas forced to cultivate mountainous, marginal, forest and protected communal land. On the other hand, to combat soil erosion soil conservation measures has been constructed. However, the conservation measures were not sustainable due to un controlled agricultural activity near or on SWC measures which disturbed structures with less or without frequent maintenance.
Less treatment at the upper stream of the gully**:** gully erosion is commonly occurred in the highlands having fragile and shallow soil coupled with intensive and frequent cultivation either with oxen plough or hand hoe. In most cases, the runoff due to excessive rainfall has not been treated with appropriate conservation structure resulted in severe rill gulley.
Overgrazing**:** communal land in the highlands are mainly utilized for free and un controlled grazing exposing the top soils to be washed away. Farmers living in areas where farm land is limited for their agricultural activity, prefer to use communal land to graze their herds. In most cases, they are reluctant to apply and/or implement SWC measures on communal land for their short term comparative advantage of feed source.

5. Current Situation of SWC in SNNPRs

Since 2011, the Ethiopian government advocated collective action on physical soil and water conservation works that, all regions are implementing the action by motivating and giving awareness for farmers. Collective action is one of the best participatory approaches which have its own by-laws led by local leader assigned by the community itself. In SNNPR, the first round public massive SWC work was launched on January 2011 for consecutive 30 days, the second in February 2012 and currently the third round on March 2013 for 30 consecutive working days. In this campaign program, farmers make a chain of development group whose farm is adjacent at village level by developing good team spirit. Each *kebele* was divided to mini-watershed in which farmers make a group and construct physical SWC in an agreed program with full responsibility.
Annually the campaign is started in February, where most parts of the region is off season for agricultural activity thus farmers have less work load which make them willing to do on SWC. Prior to the construction, training is executed for the aim of awareness creation in each mini watershed. In the dry season various types of

physical structures are constructed while in rainy season, farmers are provided with biological stabilizer for sustaining the physical structures. Most of the development agents have been trained on the design and types of structures, how and where to apply them depending on the type of soil, slope and nature of the land. In addition to the massive public work, the regional government has implemented Sustainable Land Management (SLM) project in selected six zones since 2010. The project was targeted on motivation of farmers for construction of soil bund on their farm. The project provides seedlings of fruits and coffee, biological stabilizers like vetiver grass for those farmers who construct soil bund.

As opposed to the past, in the current community based massive watershed management, people are actively participating in problem identification, planning, technology choice, designing and leveling, community by-laws settings, implementation, monitoring and evaluations and maintaining of the structures. Among the major interventions, structures like terracing, stone and soil bunds, trench bunds, check dams construction using gabion and local materials, cut of drain, micro and ibro basin, *fanya juu* and small water harvesting ponds are constructed in dry season. In the rainy season, physical structures are supported with biological bund stabilizers. Moreover, area enclosure of communal land, afforestaion, nursery establishment, seedling raising, maintenance of SWC structures are part and parcel of the massive public watershed management interventions.

Progress report from all intervention areas to higher administrative level is communicated daily using telephone and fax. This shows how the government is giving special focus to the sustainable land management. However, the case of sustainability in terms of monitoring and evaluation with maintenance of the constructed terracing, soil bund, fanya juu terrace or any other structure is under question due to the plan and construction activity mainly focuses on new physical structures than maintaining earlier structures. In general, the massive public program is not only conserving soil and water but also empowering and creating awareness among farmers on resource utilization as well as the benefit and concept of integrated watershed management which this may reverse the sustainability issues and constraints of previous efforts of soil and water conservation measures.

6. Strategies for Reducing Soil Erosion in the Region

According to FAO (2006) the slope of farm land was classified as the area with flat to gently sloping (1-7%), strongly sloping (7-15%), moderately steep (15-30%), and steep to extremely steep (>30%) slopes. Based on the literature and agro-ecological nature of the region, the following management options are forwarded for different slope lands as follows:

6.1. Areas with high rainfall like southwestern parts of SNNPRs

a. The soil erosion from slope up to 7% is not serious problem but it need to be supported with agronomic practices like contour cultivation, strip cropping, crop rotation, mulching, residue and mixed cropping. Experiments shows that soil losses on slopes up to 7% is less and can be reduced by 50% when agronomic practices are applied (WOCAT, 2003).
b. Slope between 7% to 15% need to be treated with construction of graded soil bund or graded fanya juu, with assumption of removing excess water from the field and also it should be supported by biological stabilizers. There should be also agronomic practices in between bunds. Contour grass strips can be used for preventing erosion on less slope around 6% to10%.
c. Lands having slope 15% to 30% is unsuitable for cultivation of seasonal crops which require frequent tillage unless supported by physical soil and water conservation structures. This is because high rainfall in the area with frequent tillage (3 to 5 times) can aggravate soil erosion. Structural measures like terraces, bunds, dams, cut off drains are recommended strategies to control run off, wind velocity and erosion (WOCAT, 2003).
d. Slopes more than 30% should not be used for cultivation. It should be used for fruit, agro forestry, forestry, forage production and coffee plantation. If cultivation is needed, bench terrace with strong riser which can prevent land sliding should be constructed. Land use change, area closure, rotational grazing, cut and carry system, orchard planting supported by water harvesting are best management measures for such sloppy lands (WOCAT, 2003).

6.2. Areas with low and erratic rainfall like central and southern parts of SNNPRS

a. For slopes up to 7% agronomic practice can satisfy the conservation requirement.
b. Slope between 7 to 15% need to be treated with level soil bund or fanya juu or stone bunds with biological stabilizers with assumption of collecting rain water from the channel. There should be also agronomic practices in between bunds. Contour grass strips, hedge barriers, wind breaks can be used for preventing erosion on less slope lands around 6-10%.
c. Lands having slope 15% to 30% is unsuitable for cultivation of seasonal cash crops unless supported by physical SWC structures. Most of the areas under this category are affected by gully erosion due to the slacken property of rift valley soils. Level soil bund, level *fanya juu* and scattered or alternate trenches are important physical structures to be applied in this area. It is highly recommendable to support the structures with biological stabilizers.

d. Lands with more than 30% slope and degraded mountainous areas should not be used for cultivation. Area closure, cut and carry of grasses followed by fruit, coffee and forage production can suit for these areas. Some southern parts under this category can be used for planting fruits and agro forestry trees with application of level bench terraces. Susceptible soils in the area with erratic rainfall can aggravate soil erosion and gully formation. For such cases, community based watershed management is recommended as preventive measure.

7. Conclusion and Rrecommendations

For success of soil and water conservation activities in the south region, the following recommendations should be considered as a best alternative and complementary actions.

1. Use of agronomic conservation measures: in densely populated areas of the region, where there is gentle slope up to 10% (WOCAT, 2003, Panda, 2007), farmers should use agronomic conservation practices to improve soil fertility, conserve soil moisture and then to reduce runoff. Contour cultivation, strip cropping, tree planting, manuring, mulching, and choice of appropriate cropping systems like intercropping and crop rotation are the major ones. These measures should be applied either alone or as complementary together with physical soil and water conservation measures based on slope profile and farming practices of the area.
2. Complement physical soil and water conservation measures with biological stabilizers: the constructed mechanical soil and water conservation structures such as contour soil and stone bunding, bench terracing, fanya juu terracing, etc. should be integrated and complemented with biological stabilizers. Integrating mechanical SWC with biological ones is instrumental for the sustainability of the structure and gives short term benefits to farmers.
3. Complementing SWC measures with agricultural inputs: during implementing integrated soil and water conservation practices, inputs like improved seed, animal breed, fertilizer, fruit seedlings should be given to participants either on cash or credit basis. This give opportunity to farmers to increase their crop yield and give sense of ownership to SWC structures.
4. Appropriate use of incentives: it has been repeatedly reported that incentives have negative impacts for soil and water conservation practices. Incentives obtained from Food-for-Work or Productive Safety Net Programme should not be considered a way to obtain food or money for survival, rather farmers must be convinced that the incentive assist them in increasing agricultural production through constructing and maintaining SWC measures.
5. Socio-economic and environmental profile: the socio-economic characteristics such as wealth, demographic traits, asset ownership, farming/and pastoral system characteristics has to be known before interventions. Moreover, the environmental conditions of the area such as land use and suitability, climatic condition, natural resource endowments and technology suitability have to be considered in planning and implementing SWC measures.
6. Effective approach: collective action (CA) is one of the best participatory approach to mobilize, lead and guide a given community to implement and maintain massive soil and water conservation measures. In CA, no top-down approach that all members participate in all stages of intervention. Therefore, in implementing massive public SWC works, there has to be collective action specific to each locality and system to halt land degradation and soil erosion.
7. Adoption and dissemination of SWC technologies**:** the rate of adoption of SWC techniques is very low and creeping which speeds up severity of land degradation and soil erosion. Any intervention in soil conservation should recognize the heterogeneity of household characteristics, land holding, institutional patterns and technology traits. Thus, for adopting and disseminating such techniques farmers' perception and awareness to benefit and risk of introduced SWC techniques should be increased by offering training to farmers.
8. Integrating indigenous soil and water conservation: any interventions focusing in introducing exotic SWC techniques to specific locality, conservationists and development practitioners should incorporate the long aged and socially valued indigenous SWC techniques.
9. Consideration of policy issues on sustainable land management: policy issues on natural resource management such as people access to use and mange land, ownership structure of land, size of land, land use plan, social and economic objectives of land reform of the region should be considered in implementing sustainable and efficient SWC interventions.
10. Following holistic and integrated watershed approach**:** starting in 2010/11, the government of Ethiopia and the regional states including SNNPRs are implementing community based integrating watershed management. For its sustainability and effectiveness important lessons from the past achievements and experiences of bench mark countries should be customized and operationalized. Moreover, holistic and integrated approach should be followed in planning, implementing, monitoring integrated watershed management for each agro-ecology.

References

Atakilite, B., 2003. Soil conservation, land use and property rights in Northern Ethiopia: Understanding environmental change in smallholder farming systems, PhD Dissertation, SUAS, Uppsala, Sweden.

Ayalneh, B., 2002. Land degradation, impoverishment and livelihood strategies of rural households in Ethiopia: Farmers' perceptions and policy implications. PhD Dissertation, Shaker Verlag 2002, Germany.

Bureau of Statistics and Population (BoSP), 2004. Demographic Statistical Abstract. Southern Nation Nationalities and Peoples' Region, Awassa.

CSA (Central Statistical Agency), 2008. Summary and Statistical Report of the 2007 Population and Housing Census: Population Size by Age and Sex. Federal Democratic Republic of Ethiopia Population Census Commission, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency), 2010. Agricultural Sample Survey 2009/2010 (2002 E.C.), Statistical Bulletin, Addis Ababa.

FAO (Food and Agricultural Organization), 2001. Two essays on socio- economic aspects of soil degradation. FAO Economic and Social Development Paper. No 149. Rome: 1-11.

FAO (Food and Agricultural Organization), 2006. Guideline for Soil Description, 4th ed., ISBN: 9789251055212, Stylus Publishing, LLC, Rome.

Genene. T. and B. Wagayehu, 2010. Farmers' perceptions of land degradation and determinants of food security at Bilate watershed, Southern Ethiopia. Ethiopian Journal of Applied Science and Technology (EJAST), 1(1): 55-57.

Gete, Z., 2000. Land scape dynamics and soil erosion process modeling in the Northwestern Ethiopian highlands. PhD Dissertation, *African Studies Series A16*, Geographica Bernengia, Berne.

Hurni, H., 1995. Soil Conservation in Ethiopia: a guide lines for development agents. Ministry of Natural resource development and environmental protection, Switzerland.

IFPRI (International Food Policy Research Institute), 2006. Atlas of the Ethiopian Rural *Journal of the International Association of Agricultural Economics* (IAAC), 18(3): 233-247.

Kassie. M., H. Stein, K. Gunnar and B. Randy, 2008. Economics of soil conservation adoption in high- rainfall areas of the Ethiopian highlands. Discussion paper series, EfD DP 08-09.

Kruger. H.J., F. Berhanu, GM. Yohannes and K. Kefeni, 1997. Soil Conservation Reserch Programme and Center for Development and Environment, Research Report No 34. Center for Development and Environment, Institute of Geography, University of Berne, Switzerland.

Panda, SC., 2007. Soil Water Conservation and Dry Farming. Agrobios, India.

Pender. J., E. Nkonya, P. Jagger, D. Sserunkuuma and H. Ssali, 2004. Strategies to increase agricultural productivity and reduce land degradation: Evidence from Uganda. *Agricultural Economics* 31: 181-195.

Shiferaw. B. and S.T. Holden, 1998. Resource degradation and adoption of land conservation technologies in the Ethiopian Highlands: A case study in Andit Tid, North Shewa. *The Journal of the International Association of Agricultural Economics* (IAAC), 18(3): 233-247.

Tadesse. M. and K. Belay, 2004. Factors influencing adoption of soil conservation measures in Southern Ethiopia: The case of Gununo area. Journal of Agriculture and Rural Development in Tropics and Subtropics, 105 (1): 49-62.

Tesfaye, B., 2003. Understanding Farmers: Explaining soil and water conservation in Konso, Walaita and Wello, Ethiopia.PhD Thesis, Wageningen University and Research Center.

Waga. M., G. Deribe, A. Tilahun, D. Matta and M. Jermias, 2007. Challenges of Collective Action in soil and water conservation: The case of Gununo watershed, Southern Ethiopia. pp.1542-1544. In: proc.of African Crop Science Society, 2007, Kampala, Uganda.

Wagayehu, B., 2005. Stochastic dominance analysis of soil and water conservation in subsistence crop production in the Eastern Ethiopian highlands: The case of the Hunde-Lafto area. *Environmental and Resource Economics* 32: 533-550.

WOCAT (World overview of conservation approaches and technologies), 2003: A Framework for Documentation and Evaluation of Soil and Water Conservation. Part A Approaches, Part B, Technologies. CDE, Bern.