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Role of Watershed Management for Reducing Soil Erosion in Ethiopia

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ABSTRACT

Watershed management implies the wise use of natural resources like land, water and biomass in a watershed to obtain optimum production with minimum disturbance to the environment Soil erosion is the main cause of land degradation that affects soil properties and ecosystems in Ethiopia. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile lands and other factors attributed to population pressure. Ethiopia has a history of watershed management initiatives dating back to the 1970s. The present government started community based integrated watershed management practice. Keeping these in view the study entitled "Watershed Management in Highlands of Ethiopia: Soil conservation in Ethiopia is therefore not only closely related to the improvement and conservation of ecological environment, but also to the sustainable development of its agricultural sector and its economy at large. Ministry of Agriculture and Rural Development in collaboration of donor agency such as world food program in Amhara, Oromia, and Tigray National Regional state various conservation and rehabilitation of natural resource were implemented as a result positive impact were achieved. The watershed management practices played a crucial role in arresting runoff and help to reduce erosion hazard. In view of that at the pilot watershed level a total of 297 km hillside, 27,783 trenches, 446 m3 Gabion, 3167 m3 stone check dam, and 854 m3 sediment storage, 586 m3 gully rehabilitation/re-vegetation, 80 ha bund stabilization, 25 km construction of recharge pits have been constructed over the degraded hillsides. Watershed management is practiced as a means to increase rain fed agricultural production, conserve natural resources and reduce poverty in the highlands of Ethiopia which are characterized by high soil erosion, and severe natural resource degradation. Community participation should be improved by giving recognition to environmental, economic and social issues while planning and implementing watershed management

Keywords : Soil erosion, Watershed Management, Soil and Water Conservation

I. INTRODUCTION

Watershed management implies the wise use of natural resources like land, water and biomass in a watershed to obtain optimum production with minimum disturbance to the environment (Wani, 2011). In the past, the concept of watershed management focused mainly on the management of these resources in medium or large river valleys, designed to slow down rapid runoff and excessive soil erosion, and to slow the rate of siltation of reservoirs and limit the occurrence of potentially damaging flash flooding in river courses (Desta et al. 2015). At present, the overall objectives of watershed development and management programs take the watershed as the hydrological unit, and aim to adopt suitable measures for soil and water conservation, provide adequate water for agriculture and domestic use, and improve the livelihoods of the inhabitants. Managing watersheds for sustainable rural

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development in developing countries is in practice (Esser, 2002) as cited in (Alemu 2016). It is concerned not only with stabilizing soil, water and vegetation, but also with enhancing the productivity of resources in ways that are ecologically and institutionally sustainable (Mamuye 2013). Watershed management is practiced as a means to increase rain fed agricultural production, conserve natural resources and reduce poverty in the semi-arid tropical regions of South Asia and Sub– Saharan Africa, (Kerr, 2002).

Soil erosion is one of the most serious environmental problems in Ethiopia. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile lands and other factors attributed to population pressure. On the other hand, traditional cereal farming in Ethiopia is not only low yielding but also results in the mining of plant nutrients from the soil (Esser & Haile 2012). According to Girma (2001), Ethiopia loses annually 1.5 billion metric tons of topsoil by erosion out of this 30% of soil loss is reduced due to watershed management practices in the past decades.

Ministry of Agriculture and Rural Development in collaboration of donor agency such as world food program in Amhara, Oromia, and Tigray National Regional state various conservation and rehabilitation of natural resource were implemented as a result positive impact were achieved (Dinka, 2014). The watershed management practices played a crucial role in arresting runoff and help to reduce erosion hazard. In view of that at the pilot watershed level a total of 297 km hillside, 27,783 trenches, 446 m3 Gabion, 3167 m3 stone check dam, and 854 m3 sediment storage, 586 m3 gully rehabilitation/re-vegetation, 80 ha bund stabilization, 25 km construction of recharge pits have been constructed over the degraded hillsides (Moges, 2013). For the same pilot watershed in 2006, over 35 ha of closed hillside and 2.5 ha gullies were planted with pigeon pea (edible seed), and sesbania and about 77,945 tree lucern forage seedling were planted Following watershed management practice, local communities observed the natural resource rehabilitation, different species of shrubs, grass, sesbania (sesbania sesban), acacha (Acacia decurrence) and wildlife were visible which were not in the past (Adugna 2015). Landless community members to whom the treated land was allocated and getting economic benefit from selling grass, in addition to these there are different micro enterprise development for gabion wire box production, which contribute unemployment reduction (Tadesse et al. 2014).The objective of this seminar is to review the role of watershed management for reducing soil erosion in Ethiopia; as Watershed management is vital to the achievement of food security, poverty reduction and environmental sustainability in the country.

II. METHODS AND MATERIAL

Roles of watershed Management in erosion control

2.1 Basic Concepts

Watershed is a unit of area that covers all the land which contributes runoff to a common point or outlet and surrounded by a ridge line (Sally et al. 2013).

Watershed management is a term used to describe the process of implementing land use practices and water management practices to protect and improve the quality of the water and other natural resources within a watershed by managing the use of those land and water resources in a comprehensive manner (Ervin et al. 2016). It is the study of the relevant characteristics of a watershed aimed at the sustainable distribution of its resources and the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, and human communities within a watershed boundary. Features of a watershed that agencies seek to manage include water supply, water quality, drainage, storm water runoff, water rights, and the overall planning and utilization of watersheds. Landowners, land use agencies, storm water management experts, environmental specialists, water use surveyors and communities all play an integral part in watershed management (Builder 2013).

2.2 Soil Erosion

Soil erosion is the wearing away of the land surface by physical forces such as rainfall, flowing water, wind, ice, temperature change, gravity or other natural or anthropogenic agents that abrade, detach and remove soil or geological material from one point on the earth's surface to be deposited elsewhere'. Soil erosion is normally a natural process occurring over geological timescales; but where (and when) the natural rate has been significantly increased by anthropogenic activity accelerated soil erosion become a process of degradation and thus an identifiable threat to soil (Choi 2007).

The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks (Rosegrant, 2002).

While erosion is a natural process, human activities have increased by 10-40 times the rate at which erosion is occurring globally (Wato et al. 2012). Excessive (or accelerated) erosion causes both "on-site" and "off-site" problems. On-site impacts include decreases in agricultural productivity and (on natural landscapes) ecological collapse, both because of loss of the nutrient-rich upper soil layers. In some cases, the eventual end result is desertification. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses (Bartelmus 2002).

Water and wind erosion are the two primary causes of land degradation; combined, they are responsible for about 84% of the global extent of degraded land, making excessive erosion one of the most significant environmental problems world-wide (Pagiola, 2002). Intensive agriculture, deforestation, roads, anthropogenic climate change and urban sprawl are amongst the most significant human activities in regard to their effect on stimulating erosion. However, there are many prevention and remediation practices that can curtail or limit erosion of vulnerable soils (Wiesmann, 2010). Soil erosion reduces the productivity of agricultural lands by removing topsoil, exposing less desirable subsoil. It results in a loss of organic matter and nutrients causing a reduction of fertility and plant available, water-holding capacity (Duryea et al., 2008).

2.3 Watershed Management Practices in Ethiopia

Ethiopia has a history of watershed management initiatives dating back to the 1970s. The institutional strengthening project was implemented by FAO, and was principally aimed at capacity building of Ministry of Natural Resources' technicians and experts and development agents in the highland regions of Ethiopia. The projects used the sub-watershed as the planning unit and sought the views of local technicians and members of the farming community to prepare of land use and capability plans for soil and water conservation. This approach was tested at the pilot stage through FAO technical assistance under MOA during 1988-1991(MOARD, 2005). This was the first step in the evolution of the participatory planning approach to watershed development (Moges, 2013).The approach by soil conservationists in the 1980s is moving away from using mechanical works and structures in soil conservation programs paid for by a government or a donor-funded project. An example is the increasing awareness of the ineffectiveness of terracing programs alone. Also, we are moving towards the view that the only effective programs are those which have the full support of the people (Esser & Haile 2013).

In order to extensively address the problem of natural resource degradation, conservation schemes were introduced, especially after the occurrence drought and famines in 1970s. Starting from 1970s and onward, huge areas have been taken under soil and water conservation activities, and millions of indigenous tree species were planted, through community participation covering huge area by trees, forest and community woodlots (Mulatie, 2015). Food for work project funded by World Food Program was implemented with the objectives to employ labor force of the farmers to participate into the plantation, soil and water conservation activities in lieu of food grain and edible oil (Wolancho 2015). The drawback in the implementation of this program was its poor involvement and participation of local people in the planning and implementation of the scheme, shortage of skillful man power, ill planned and ill defined soil and water conservation policy, lack of commitments to address the problem, ignoring the interests of rural communities, theoretical emphasis given on natural resources conservation, lack of scientific approach and lack of technical knowledge. After the withdrawal of Food for Work program most of the farmers refused to participate in the activity. Even some of the farmers removed soil and water conservation structures from their fields (Bahri et al,. 2013)

During 1980-90, the government implemented rehabilitation of natural resources in Ethiopia through watershed development and management on pilot basis with the support of FAO and aimed at developing extension agents through capacity building for Ministry of Natural Resources. The project used the sub-watershed as the unit area for planning and management involving the participation of local people. This was the initial stage in the evolution of the participatory planning approach to watershed development. Ever increasing population posed pressure on watershed resource especially in mountainous region resulted into deteriorating condition of natural resources. In order to reverse this process of natural resources degradation, the government of Ethiopia adopted top down approach in management. This undermined the needs of the participation of local community, therefore recorded limited success in sustainable watershed management. The program implementation committee reviewed the problem and adopted bottom-up approach involving local communities in planning and management of natural resource through watershed project. The problems of local community towards watershed planning and management were addressed using local & indigenous knowledge and supported by scientific research and innovative technology. Local community had rich understanding of indigenous techniques about climate, soil fertility and biodiversity problems confronted by the farmers (Mekuria et al. 2009). The basic approach has shifted from top-down infrastructure solutions to community based approaches. There is now a supportive policy and legal framework in the form of policies that facilitate decentralized and participatory development, institutional arrangements that allow and encourage public agencies at all levels to work together, and an approach to natural resources that affects local legislation and tenure practices (Mitiku, 2011).

In 1991, the Ethiopian government designed a new economic policy based on Agricultural Development-Led Industrialization. Natural resource conservation based agriculture development became the primary objectives of industries. Industries gave impetus to improved watershed management adopting, different soil and water conservation practices, and rehabilitation of watershed through afforestation, community woodlots development and construction of micro and small scale irrigation projects. Watershed development and management in Ethiopia has been taken up under poverty alleviation and environmental conservation program. It started through Community based Watershed Development Program as a comprehensive development concept for sustainable and efficient utilization of natural resources for the benefit of the local community with special attention to the rural poor (Delgado et al. 2011).

Participatory watershed planning and management is fostered by community participation under diverse socio-economic and biophysical situations and suitable organizational institutional structures that are being established in Ethiopia. It is often argued that watershed planning and management program should restructured so that it is site-specific, embraces livelihoods, productivity and sustainability to varying socio-economic condition (Getachew, 2014). Well managed watershed play a key role in the improvement of the life of watershed community through access to fodder for their livestock, expansion in off-farm economic activities, reduction in natural resource degradation and socio economic conditions. Access to employment opportunities outside farming could help to reduce the pressure on natural resource and emerging landlessness. Land tenure certification encourages farmers to invest in long-term soil and water conservation activities, to obtain credits, to adopt intensive farming practices and to make sustainable use of watershed land (Wolde 2010).

Land degradation has been long recognized as a major impediment to economic growth and famine preparedness in Ethiopia, and efforts have been made to address the problem especially in the last quarter of the 20th century. Since 1999, the Government's policy has been Agricultural development-led industrialization. This policy included improvements in technology and management in the agriculture sector; investment in infrastructure and other inputs to agriculture; and increasing farm size with a reduction of the population depending directly on agriculture (Alemu 2016). Specific programs have been initiated, usually sponsored by bilateral or multilateral donors. Many of these have dealt with the physical infrastructure. For example, between 1976 and 1985, 600,000 km of soil and stone bunds were constructed on arable land; 500,000 km of hillside terraces were constructed; 500 million tree seedlings were planted; and 80,000 ha set aside for natural regeneration (Wolancho 2015). However, by the mid-1980s conservation activities had been undertaken on only 1 percent of the highlands, only 15–20 percent of seedlings had taken root and much of the physical infrastructure was imposed without much input from stakeholders and in some cases using coercion. Consequently, these structures were not well maintained (Mekonnen et al., 2015).

A World Bank project is addressing decentralized agricultural research and restoration, and food security issues are the focus of a number of donors. However, in his opening address to a recent conference the Minister of Agriculture (Mulu, 2015). The Ethiopian government has for a long time recognized the serious implications of continuing soil erosion to mitigate environmental degradation and as a result large national programs were implemented in the 1970s and 1980s. However the efforts of these initiatives were seen to be inadequate in managing the rapid rate of demographic growth within the country, widespread and increasing land degradation, and high risks of low rainfall and drought. Since 1980, the government has supported rural land rehabilitation, these aimed to implement natural resource conservation and development programs in Ethiopia through watershed development (MOARD, 2005).

GTZ-Integrated Food Security Program South Gondar, with Integrated Watershed Management Approach assistance aimed at improving the nutritional food insecure households in south Gondar through natural resource management by biological and physical soil conservation measures, crops and rural infrastructure works (GTZ-IFSP, 2002). The project succeeded with gully rehabilitation approach. At present a wide variety of donor and development agencies are promoting watershed development. In Ethiopia Watershed management was merely considered as a practice of soil and water conservation (Adugna 2015). The success stories of early watershed projects were marked as the basis of major watershed initiatives in Ethiopia. But only technological approaches were adopted from those early successful projects and the lessons related to institutional arrangements were neglected. The newly implemented projects neither involved nor took effort to organize people to solve the problem collectively. Where village level participation was attempted they typically involved one or two key persons like village leaders. These projects failed due to their centralized structure, rigid technology and lack of attention to institutional arrangements (Gashaw et al. 2014).

The impacts of physical SWC measures can be classified into short- and long-term effects based on the time needed to become effective against soil erosion (Adisu, 2011). The short-term effects of stone bunds are the reduction in slope length and the creation of small retention basins for run-off and sediment. These reduce the quantity and eroding capacity of overland flow. Such effects appear immediately after construction of the stone bunds and reduce soil loss (Belay, 2014). Under the SWC program, various types of physical and biological SWC measures have been undertaken in the watershed with full participation of the communities since the 1980s (Regassa et al., 2011).

Prior to the 1974 revolution, soil degradation did not get policy attention it deserved (Keesstra, 2015). The famines of 1973 and 1985 provided a momentum for conservation work through large increase in food aid (imported grain and oil). Following these severe famines, the then government launched an ambitious program of soil and water conservation supported by donor and non-governmental organizations and soil conservation measures have relied largely on food-for-work programs as an incentive and have been oriented toward labor intensive activities such as terracing, bund construction and tree planting (Hailemariam, 2014).

The World Bank has given more importance to vegetative measures in watershed management. This supports the global trend that favors choosing technologies that are low cost and more farmers friendly "Successful adaptation of this technology in the World Bank projects was achieved by involving farmers in the choice of technologies, a strategy that helps to implement technologies that are more compatible with existing land uses and surrounding environments and that meet farmers needs" (World Bank, 2001) as cited in (Woldemichael 2012).

Interventions and impacts in the late 1990s the Tigray Bureau of Agriculture and Natural Resources piloted an integrated community based watershed management approach (with support from Irish Aid) that drew training and experience from successful participatory watershed management in India (Adugna 2015). A key insight was the economic benefits that arose for communities once the upper catchment areas of a watershed were rehabilitated. Rehabilitation led to a recharge of groundwater in the lower catchment. Areas that previously depended on unreliable rain-fed production were transformed by a rapid and substantial growth of micro-irrigation as farmers sunk their own wells, in some cases investing in small motor pumps or treadle pumps (Tadesse et al. 2014).

The government of Ethiopia and the WFP merged farmers' priorities with technical specifications for watershed and soil management. The result was a Local Level Participatory Planning Approach that, in 2003, developed into the MERET program (Managing Environmental Resources to Enable Transitions to more sustainable livelihoods). The program now covers over 450 watersheds in 72 chronically food-insecure woredas (districts) across five regions (Amhara, Oromiya, SNNP, Tigray, Somali) and Dire Dawa Administration, reaching approximately 640,000 beneficiaries per year (Hadgu, 2011). Over the years, more than 400,000 hectares of degraded land have been rehabilitated under MERET, helping households raise their incomes in absolute and relative terms, as well as increasing agricultural production (Gashaw et al. 2014).

A recent impact evaluation found that two-thirds of all Managing Environmental Resources to Enable Transitions (MERET) households (compared to less than half of the control site households) have escaped from poverty during the past ten years that is MERET has delivered a 20 per cent reduction in poverty in its project areas. MERET has similarly reduced participating communities' dependence on emergency relief (Deressa, 2012). The interventions have also improved food security. MERET households consume a more diverse diet, and significantly more MERET households consume 'acceptable' diets compared to control site households. In 2005, the government of Ethiopia, with funding from nine development partners, expanded the Approach further, introducing a new way of helping chronically food insecure households while building assets through public works schemes. This Productive Safety Net Program (PSNP) covers several thousand watersheds in 319 chronically food insecure woredas (districts) in six regions (Afar, Amhara, Oromiya, SNNP, Tigray and Somali) as well as in Dire Dawa and Harari urban administrative areas. It includes, but goes beyond, MERET's successful projects, taking chronic food insecurity as its focus rather than watershed management. With an annual budget of approximately $US450 million, the program targets around 7.8 million people in a normal year (and that rose to around 11.6 million (Worku, 2015)

2.4 Watershed Management practices for soil conservation.

Between 1976 and 1988, some 800,000 km of soil and stone bunds were constructed on 350,000 ha of cultivated land for terrace formation, and 600,000 ha of steep slopes were closed for regenerationin Ethiopia (Burek et al. 2015). These conservation structures were introduced with the objectives of conserving, developing and rehabilitating degraded agricultural lands and increasing food security through increased food production/ availability (Damtew, 2015).

2.4.1Terracing

An interesting example is the terracing activity of Konso farmers in Southern Ethiopia. Other soil conservation measures including fallowing, crop rotation, strip cropping, manuring, ditch building are practiced extensively. As part of the mass mobilization efforts, between 1975 and 1989, terraces were built on 980,000 hectares of cropland; 208,000 hectares of hillside terraces were constructed and 310,000 hectares of highly denuded lands were re-vegetated (Gezahegn, 2003). On the contrary to these considerable efforts and achievements, the country is still losing an appreciable amount of precious topsoil annually. Thus, the required level of conservation has not been met yet (Yohannes, 1994) Terracing has been developed under traditional agriculture in the Highlands of Tigray (Virgo et al. 1977), North Showa, in the Charcher Highlands and in Konso (Huffnagel 1961, Westpha11975). In the Characher Highlands, soil and stone bun& were built primarily for the cultivation of coffee (Cof- fee arabica) and chat (Kata adulis) (Worku, 2015).

2.4.2 Soil (stone) bund

Between 1976 and 1990, 71,000 ha of soil and stone bunds, 233,000 ha of hillside terraces for afforestation, 12,000 km of check dams in gullied lands, 390,000 ha of closed areas for natural regeneration, 448,000 ha of land planted with different tree species, and 526,425 ha of bench terrace interventions were completed (USAID, 2000) mainly through Food-for-Work (FFW) program incentives (Kirubel, 2011)

In 2004, 2005 and 2006 the length of constructed soil bund in the study area was 779.42km, 815 km and 970 km, respectively. However, the trend of constructing soil bunds declined as of 2007(Ahmade 2013). Between 2007 and 2009, the district's agricultural and rural development office planned to construct 369km of soil bunds in each year. But around 254 km, 325 km and 274.6 km soil bunds were accomplished in 2007, 2008 and 2009, respectively. Although maintenance was planned for 540 km soil bunds for the year between 2007 and 2009 at district level, only about 325 km, 401.3km and 445km were completed (Burek et al. 2015).

2.4.3 Contour bounding

Contour bunds are earth embarks, 1.5 to 2m wide thrown across the slope to act as a barriers to run-off, to form a water storage area on their up slope side and to break up slope in to segment shorter in length is required to generate over land flow. They are suitable for slope 1^0 to 7^0 the bank spaced at 10 to 20m and are generally hand constructed (Afegbua et al. 2016). In other ways Contour plowing is carrying out plowing, planting and cultivation on the causes can reduce soil loss from slopping by up to 50% compared with cultivation up and down the slope. The effectiveness of counter farming is various with the slope steepness and slope length. Moreover, this technique is only effective during storm of low rainfall intensity. Protection against more extreme storm is improved by supplementing contour farming with strip cropping (Gorfu et al., 2011). Is a practice of tilling the land along the contours of the slope in order to reduce the runoff on a steep sloping land. It is used separately or in combination with other conservation structures such as plantation trees and cut- off drains (Tatek 2014).

2.4.4 Fanya juu

Fanya juu is usually applied in cultivation land with slopes above 3% and below 16% gradient. It can also be constructed in uniform terrains with deep soils. Moreover, it has a potential to increase/sustain soil productivity and environmental protection. The district's agricultural and rural development office merged the soil bunds and fanya juu structures in its plan and claimed to construct 1000 km structure (soil bunds and fanya juu) and maintenance of 500 km of various conservation structures in 2010/11 (Tegegne, 2014).

2.4.5 Traditional agro-forestry and agronomic SWC measures

Agronomic measures reduce the impact of rain drops through interception and thus reduce soil erosion and increase infiltration rates and thereby reduce surface runoff and erosion (Builder 2013). A widely used agronomic measures includes contour plough, strip cropping, mixed cropping, inter cropping, green manure, alley cropping and crop rotation with legumes (Demeke et al. 2015).

Biological measures are effective methods of SWC and they can be used jointly with structural and agronomic measures (Health, 1998). There are different biological SWC including; vegetative strip and grass cover. Enset (Ensete ventricosum) is traditionally grown in west Ethiopia (Keffa) together with tobacco, cabbage and some leguminous crops around the homestead (Getachew, 2014). Coffee and chat, both perennial cash crops, are grown in west, south and eastern highlands together with other crops, mostly annual, in order to make maximum use of farm land. Such intercropping of perennials and annuals provides a multi-story canopy system which protects the soil against the effect of falling raindrops before the harvest of the annuals. However, this function is inexistent during the short period between harvesting and next sowing season. This system was not basically established for soil conservation, rather to increase production through intercropping (Atnafe et al. 2015). These measures predominantly applied to control runoff and prevent loss of soil erosion, to improve soil fertility, they are the cheapest way (Bortolozo et al. 2015).

III.CONCLUSION

Generally Watershed management is very essential to reduce soil erosion especially in developing countries as the main source of income and food is agriculture soil erosion causes very severe effect on communities' livelihood, in addition soil erosion is the main cause of land degradation that affects soil properties and ecosystems in Ethiopia. Ethiopia loses annually 1.5 billion metric tons of topsoil erosion out of this 30% of soil loss is reduced due to watershed management practices in the past decades. In Ethiopia management of watersheds have been practiced by using a variety of technologies such as vegetation conservation like grass contours, alternative tillage techniques and physical structures like terraces, stone bunds, gabion box etc. Following watershed management practice local communities were gained multiple benefits. At present, the overall objectives of watershed development and management programs take the watershed as the hydrological unit, and aim to adopt suitable measures for soil and water conservation, provide adequate water for agriculture and domestic use, reduce soil erosion and improve the livelihoods of the inhabitants. Watershed management is practiced as a means to increase rain fed agricultural production, conserve natural resources and reduce poverty in the highlands of Ethiopia which are characterized by high soil erosion, and severe natural resource degradation.

IV.Future Prospect/work line

Community participation should be improved by giving recognition to environmental, economic and social issues while planning and implementing watershed management. The current SWC based watershed management activities which are carried out by various approaches/organizations, including massive public campaign, NGOs, safety nets, etc., should intensively work on awareness of the land users so that rate of adoption can be improved. Technical support and monitoring should be strengthened to select the appropriate structures, design and specification. Wherever, possible, biological measures such as exclosures, tree and shrub planting and management, agroforestry, strengthening the structures with grass or shrub, etc., should be given priority due to their multiple and sustaining roles. Many cases studies indicated that biological measures and soil fertility management could improve effectiveness of the structure and soil fertility. The technical approach should also give due attention for livestock management which significantly creates conditions for soil erosion and damage of the built structures. Strong biophysical and socio-economic research is important to improving the effectiveness and adoption of those structures for Ethiopian conditions. Land use plans and policies should be practiced primarily for careful management and utilization of fragile and marginal areas. The policy and regulation aspect should also include transparent and enforcing commitments for maintaining/repairing the structures after they have been built by various approaches. The current motive and mobilization for SWC based participatory watershed management should be sustained and the strategy should be strengthened by national policies. For better effects, intervention should always follow watershed logic, commencing from uphill and progressing down toward the watershed outlet, but they should not be implemented in fragmented distributions. An integrated watershed management approach needs to be adopted and the soil and water conservation technologies and approaches need to be applied in field situations ,importance of conserving natural resources through integrated watershed management importance of work in close collaboration with people and different agencies and not in isolation. Further studies in the Role of watershed management for reducing soil erosion are necessary.

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