IMPACTS OF SUSTAINABLE LAND MANAGEMENT ON REHABILITATION OF DEGRADED LAND AND LAND PRODUCTIVITY: THE CASE OF SEMEN BENCH DISTRICT, BENCH SHEKO ZONE, SOUTH WEST ETHIOPIA

DEGREE OF MASTER OF SCIENCE IN SOIL AND WATER CONSERVATION ENGINEERING

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HAWASSA, ETHIOPIA

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THESIS APPROVAL SHEETS

This is to certify that the thesis entitled, ‘‘Impacts of Sustainable Land Management on Rehabilitation of Degraded Land and Land Productivity: The Case of Semen Bench District, Bench Sheko Zone, South Ethiopia ‘submitted to Hawassa University, Department of Biosystem Engineering and School of Post Graduate Studies, is a record of original research carried out by Kenbon Abera Keneni. I recommend that it be accepted as fulfilling the thesis requirements.

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DEDICATION

I dedicate this thesis research to my beloved family.

STATEMENT OF THE AUTHOR

By my signature appended below, I declare and reaffirm that this thesis titled Impacts of Sustainable Land Management on Rehabilitation of Degraded Land and Land Productivity is my own work. I have followed all ethical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis. All scholarly matter included in the thesis has been given recognition through citation or by means of reference.

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ACRONYMS AND ABBREVIATIONS

BSHZAARD	Bench Sheko Zonal Administration of Agricultural and Rural Development
CSA	Central Statically Agency
DLDD	Desertification, Land Degradation and Draught
ESIF	Ethiopian Strategic Investment Framework
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GOE	Government of Ethiopia
GTP	Growth and Transformation Plan
Km	Kilometer
LCCA	Local Climate Change Adoption
LD	Land Degradation
ME	Monitoring and Evaluation
MOFED	Ministry of Finance and Economic Development
MSL	Mean Sea Level
NGO	Nongovernmental Organization
NRM	Natural Resource Management
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
SD	Sustainable Development
SLM	Sustainable Land Management
SLMP	Sustainable Land Management Program
SNNPR	Southern Nation Nationality and People Regional
SPSS	Statistical Package for Social Science
TSL	Tepi Soil Laboratory

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IMPACTS OF SUSTAINABLE LAND MANAGEMENT ON REHABILITATION OF DEGRADED LAND AND LAND PRODUCTIVITY: THE CASE OF SEMEN BENCH DISTRICT, BENCH SHEKO ZONE, SOUTH ETHIOPIA

ABSTRACT

Land degradation in the form of soil erosion and fertility loss are very crucial problems in Ethiopian Highlands, which have serious implications for food security and livelihoods. Various SLM practices/technologies were recommended to increase agricultural productivity. But their impact is not adequately evaluated. A study was conducted to investigate the impacts of SLM practices on soil erosion and land productivity in Semen Bench district, Bench shako zone of SNNPR. The Primary data were collected through interview, focus group discussion, key informant and field observations. Two kebeles (Muya and Kasha) were purposively selected based on participation and coverage of soil and water conservation practices implemented by SLM program established in the study area. A total of 138 households were randomly selected for interview and categorizing in to adopter and non-adopter of SLM practice. Data collected were analyzed using SPSS Vs 21. Chi-square test was employed for dummy and categorical data while T-test was used for continuous data at 5% of significance level. Index was used to calculate ranking of major cause of soil erosion. The result indicates households who adopted introduced land management practice were economically more productive, soil fertility improved about 64% and soil erosion was almost controlled by 52.2% in adopters. As the land size increase by 73.6% in case of adopters, it decreases by 70.6% in non-adopters. The annual mean income was 22072.97 ± 613.53birr and 18118 ± 778.78 birr in case of Muya and Kasha for adopter and 15003.85 ± 645.64birr and 15120 ± 789.98birr in non-adopters respectively which was highly significances. Poor farming practice, over cultivation, deforestation and high rain fall were the main cause of soil degradation. Some farmer starts to use SLMP and stop after a time due to costs, complexity of designing structures, lack of awareness and need of high labor forces. Farmers focused on short term profit of SLMP rather than long term and had lack of practical training.

Key words: *Soil degradation, land productivity, Sustainable land management practice*

1. INTRODUCTION

1.1. Background

The agriculture sector in Ethiopia accounted for almost two fifths of GDP and three quarters of total employment in 2012/2013 and Economic growth rates GDP grew 10.7% per year from 2005/2006 to 2012/2013 largely depend on stable and continued growth in agricultural output (CSA, 2014a).

The Government officials and development partners have identified land degradation as a serious threat to productivity throughout the agricultural highlands of Ethiopia. There are several problems in Ethiopia; one of the greatest challenges is related to the problem of environment. Among other things, natural resource degradation in general and soil degradation in particular has great effect on the environment but particularly on agriculture. The most sever environmental problems in the country usually related to the high populated areas, where land degradation involves loss of both vegetation and soil biodiversity (EPA, 2012).

Degradation of arable land due to soil erosion is a wide spread phenomenon in the highland of the country, which share about 45% of Ethiopia's total land area. On steep slopes, estimated annual rate of soil loss due to erosion is about 114.59 tons /ha/year and land productivity in the agricultural sector has been slowed down due to land resource degradation, particularly soil erosion by water and unfavorable climatic condition besides to human activities such as deforestation, overgrazing, and over cultivation of steep slopes and marginal lands that causes land degradation, drought, famine and chronic poverty in Ethiopia (Mushir and Surur, 2012). The mixed crop livestock farming system, when left unmanaged, results in overgrazing of crop residue leaving farmland absent of groundcover and vulnerable to significant soil erosion (Amare *et al*., 2005). Recent studies in Ethiopia have estimated the loss of agricultural production due to land degradation ranges from 2% to 5% of agricultural GDP per year(Yesuf *et al*., 2005).

Sustainable Land Management (SLM) has been portrayed as a solution against desertification, land degradation and drought (DLDD) in the Sahel, the broad strip of semi arid, sparse savannah immediately South of the Sahara Desert. The used endogenous and exogenous and even mixed, but little is known about their effectiveness. Land degradation is the reduction of land capacity to provide ecosystem goods and services, especially in semi arid and dry sub-humid areas, while desertification is the long-term process of land degradation in drylands resulting from climatic variations and human activities. The dynamic connections between land, climate and biodiversity are widely recognized (UNCCD, 2013b).

Senegal is a Western Sahel country with a long coastline and most of its surface in a climatic zone prone to DLDD where lots of funding and SLM initiatives have been promoted from different strands. The evaluation of SLM in Senegal is studied to encompass the main Sustainable Development evaluation challenges but the institutional administrative and supervision of sustainable land management in Senegal is not clear. Competencies are shared between the Ministries of Agriculture, Environment-Forestry, Livestock, and other public or private sector actors. This is exacerbated by a donor-led sector, dispersed in discrete short-term Project interventions with low level of coordination. This also entails threats for SLM public policy evaluation blockages of transdisciplinary(Basle, 2013) emerging from the fact of SLM being divided between different sector domains and disciplines, each of them using its own paradigms, evaluative approaches and measures of success. Moreover, it also makes difficult the complementarily and integration of evaluation results from projects to the policy-level (MEPN, 1998; Swartzendruber, 2015). Most evaluation of SLM projects have been focused on financial indicators and the monitoring of timely delivery of outputs (e.g. “running kilometers” of conservation structures built; number of tree seedlings raised in nurseries). Output-focused and log frame-based evaluations are criticized from scientific strands as being insufficient to capture SLM objectives.

The assessment of the ecological, social and economic impacts through methods for the valuation of ecosystem services is proposed, including visual coverage analysis (Liniger, 2007). Approaches and measures for Sustainable Development (SD) evaluation are contested although it is gradually accepted the need to include a multi-level and multi-dimensional analysis encompassing social, economic and environmental systems and appropriate time horizon and geographical scope. This involves several challenges endorsed by research (Pintér *et al*., 2012; FAO, 2013a; Swartzendruber, 2015). There is different approach which examine natural resources are sustained and studied by various authors. From this approach some authors recommend participatory approaches are important for resource management, because of their inclusiveness and capacity to capture complex social dynamics and raising alternative types of knowledge.

Sustainable development involves interaction between three different domains: the environment, the economy and the society(Vanden-Berg, 2012). More of challenges in Sustainable Development evaluation are related to the inclusion of different values from different stakeholders. The discourse at different strands calls for the need of involving land users in M&E of these interventions. This is also portrayed as an opportunity to raise key information about the effectiveness of local conservation practices, land management innovations and traditional land use systems over environmental and development benefits (Liniger, 2007). Another common challenges seen when evaluating Sustainable Development interventions is related to the limited time period of those interventions in relation to environmental and socioeconomic dynamics (UNDP, 2007; Bours *et al*., 2013).

Today, there are vast areas of degraded land in Sub-Saharan Africa leading to greatly reduced productivity. During the 2002-2004 farming seasons in East & West Africa, especially Mali, Burkina Faso, Nigeria, Ethiopia, Somalia and Kenya, annual loss of soil fertility on farmlands can be as high as 100 kg per hectare mainly due to poor farmland management (Ayieko, 2008). Farmlands are the components and homelands of the basic natural resources of the globe and in which the various ecosystems interact with their environment. Thus, farmland management significantly determines the sustainability of natural resource management, and agricultural practices and productivities of a country, mainly where agriculture is the leading economic activity like in Africa in general and

Ethiopia in particular. In the study area also, agriculture was the major livelihood of the farmers which was based on mixed farming system and agro forestry.

1.2. Statements of the problems

In Ethiopia, the heavy dependence of people's livelihoods on agriculture and inappropriate use of natural resources resulted in fast and vast land degradation (Genene, 2006). On the other hand, development of agricultural sector partly depends on land productivity. However, this resource is seriously threatened by land degradation and aggravates the food insecurity problems in the country through its adverse impact on crop yield. The country could not feed its population at present and it will have difficulties doing in the near future partly due to serious land degradation (Kruger *et al*., 1997; Genene, 2006).

Failure of Ethiopian agriculture to feed the population is partly resulted from cumulative effect of land degradation mainly in the highland part of the country (Kruger *et al*., 1997; Yohannes, 1999). Therefore, improving productivity of land is so crucial in improving the welfare of the agrarian population in particular and the overall economy of the country in general (Desta, 2009). Without the proper management of land resources; it becomes very challenging for Ethiopia to feed the increasing population. As a result, there should be appropriate land management systems to improve the productivity of land particularly in highland areas where the problem of land degradation is severe (Desta, 2009).

To solve the problems of land degradation in the country; many efforts have been made since 1970s. A large number of soil and water conservation activities were implemented in different parts of the Ethiopian highlands in the 1970s and 1980s with a huge resource obtained from international community, particularly World Food Program (WFP). However, at the end the intervention couldn’t be sustainable and able to bring the intended impact (Woldamlak, 2003). Land management practices are complex issues requiring further investigations as they are influenced by different factors operating at different scales (plots, households, local, regional, national and international). Farm level decision making must be considered as most important in any attempt to understand why land users act as the way they act. It should be recognized that decisions about land management are taken by a broad variety and combination of social actors (Ayalew*et al.*, 2009).

Different researchers have done studies on land degradation status in different parts of Ethiopia. Those researchers have mainly focused on: nature of land degradation; traditional farmers‟ land management practices, ongoing soil and water conservation by government and other actors; farmers‟ perception on soil fertility change and on causes of land degradation (Genene, 2006). Most of these researchers generally found out that there is high degree of land degradation in Ethiopia in general and in the highland areas in particular. However, as far as the researcher’s knowledge is concerned, there is a research gap on the issue of what social, economic, and institutional factors affect the land management practices. Sustainable land management practices (SLMP) promise to improve agricultural productivity (Thomas, 1997).

Besides to this the impacts/effectiveness of SLMP at national level in general and local in particular on land productivity, soil erosions and livelihood of smallholder farmers were also not adequately evaluated yet. In additions, only some farmers continuously use SLM practices while others were start and stop after a time. Why?

This study has significant effects to solves the above problems and produce academic research and serves as a bench mark for future research on similar ideas.

1.3. Objective

The general objective of this thesis is to analysis the impacts of Sustainable Land Management practices on rehabilitation of degraded land and land productivity

The Specific Objectives were:

- To assess the impacts of sustainable land management practices on rehabilitation of degraded land in Semen Bench Woreda using SPSS for the year 2019.
- To analyze the impacts of Sustainable Land Management practices on livelihood of sampled farmers
- To evaluate the extents and significant effects of sustainable land management practices on reduction of soil erosion

1.4. Organizations of the thesis

This thesis is divided in to five chapters. In the first chapter, the introduction of the paper is presented. This covers background of the study, statement of the problem, objectives of the study. Chapter two presents the literature review which encompasses concepts of SLMP, Chapter three provides description of the study area and the research methodology. Chapter four contains results and discussions; Chapter five presents Summary and Conclusion of thesis.

2. LITERATURE REVIEW

2.1. Definition of sustainable land management practices

Sustainable land management is a knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fiber demands while sustaining ecosystem services and livelihoods, due to this SLM practices is necessary to meet the requirements of a growing population to prevent improper land management that lead to land degradation and a significant reduction in the productive and service functions (World Bank, 2006).

In context, Sustainable land management, has been defined as a combinations of technologies, policies and activities aimed at integrating socioeconomic principles with environmental concerns so as to simultaneously: maintain or enhance production/services (Productivity); reduce the level of production risk (Security); protect the quality/potential natural resources and prevent soil and water degradation (Protection); be economically viable (Viability); be socially acceptable (Acceptability). These five goals productivity, security, protection, viability, and acceptability have been described as the pillars of sustainable land management (Dumanskin and Smyth, 1993).

2.1.1. Sustainable land management practices in the World

Land management practices were emerged as an issue of major international concern. This is not only because of the increasing population pressure on limited land resources, demanding for increased food production, but also by the recognition of the fact that the degradation of natural resources is accelerating in many countries of the world. It is also becoming clear that the limits to lands, which are suitable for agriculture, are now being reached. If the lands, which are moderately or well suited for agriculture, are currently in use, then it follows that further increases in production, to meet the food demands of rising populations, must come about by the more intensive use of existing agricultural lands. To combat the often-cited deleterious effects of intensification, particularly with regard to environmental effects requires the development and implementation of technologies and policies, which will result in sustainable land management (Tadesse, 2011).

2.1.2. Sustainable land management practices in Africa

Since agriculture, environment and land management are interlinked, the performance of agricultural productivity and environmental health of a continent, mainly where agriculture is the main stay of the national economy, depend on the appropriateness of the management techniques to be practiced on farm plots. The management practices to be implemented have negative and positive effects. Inappropriate application of land management practices results land degradation problems (Scherr, 2012).

In the densely populated regions of Africa, intensification of agriculture is reducing fallow periods and increasing the farming intensity on cropland. On the other hand, limited access to knowledge of viable land management options, lack of capacity to invest in land especially in management practices, and having less ability to bear risk and wait for future payoffs from investment constrained farmers attempt to improve farmlands. As a result, a major part of agricultural land in Africa suffers from intensive cultivation, steep slopes, poor water control and land management, soil erosion and loss of soil nutrients, and is unlikely to support the growing population (FAO, 2011).

Land management is the key entry point for improving land resource resilience and productivity within the context of the potentially devastating effects of climate change. It is bridging the needs of agriculture and environment, with the twin objectives of maintaining long term productivity and ecosystem functions and increasing productivity of goods and services including safe and healthy food (Tadesse, 2011).

2.1.3. Sustainable land management practices in Ethiopia

Land management in Ethiopia has evolved in to various farming systems with different level of intensification (Wegayehu, 2006). In the same way, Ayalneh (2002) point out that a number of SWC techniques have been employed by farmers, most of which have their origin in the traditional knowledge but adapted to the present environmental and social circumstances by experiments through generations.

Gete *et al* (2006) classified the land management practices that have applied in Ethiopia into two broad categories: indigenous and introduced, with different degrees of acceptability, areal coverage and benefits. The acceptance and implementation of these management practices depends on the desire and willingness of farmers, which in turn request continuous and effective deeds from agricultural experts and researchers. It is not easy, in fact, to put common criteria to categorize land management practices into indigenous and introduced. As a result, this categorization is done based on the direct purposes of the management techniques why farmers apply on their farmlands in the study area (Tadesse, 2011).

The recent 5year development plans for Ethiopia highlighted sustainable land management (SLM) as a key pillar to maintaining economic growth in the Country. The Plan for Accelerated and Sustainable Development to End Poverty (PASDEP, 2006 to 2010) included a detailed outline of investment strategies for SLM activities. Similarly, the Growth and Transformation Plan (GTP, 2010/11 to 2014/15) underlined the need to identify key SLM infrastructure to address specific challenges within diverse agro ecological zones (Ministry of Finance and Economic Development (MoFED, 2010).

The Ethiopia Strategic Investment Framework for Sustainable Land Management(ESIF, 2009 to 2023) was drafted to increase SLM investments that aim at restoring and enhancing land productivity in Ethiopia. Most recently, the Government of Ethiopia (GoE) (in collaboration with the World Bank and the Gesellschaftfür International Zusammenarbeit invested in a large (ongoing) program called the Sustainable Land Management Program (SLMP) in 2009.
The SLMP is currently working in 177 critical watersheds and 209(districts) to scale up and increase adoption of appropriate SLM technologies tested for specific agro ecological conditions in the program watersheds.

The program consists of four components: integrated watershed and landscape management; institutional strengthening and capacity building of key stakeholders; improved land tenure security of smallholder farmers; and project management to support the Ministry of Agriculture to ensure efficient delivery of project resources. Constructing of SLM structures was to stabilize soils and increase water retention, afforestation/reforestation, protection of ecologically critical ecosystems, zero or low tillage agriculture, and pasture management to prevent overgrazing (World Bank, 2013). The major findings of the recently concluded Millennium Ecosystem Assessment warned that approximately 60 percent of the ecosystem supporting life on Earth was being degraded or used unsustainably and that the consequences of degradation could grow significantly worse in the next half century (MEA, 2005a).

2.2. Type of sustainable land management practices in Ethiopia

2.2.1 Indigenous sustainable land management practices in Ethiopia

Indigenous land management practices are simple structures of a short-term nature that could be reshuffled each year to make use of the soil captured above the structure and avoid rodent production (Genene and Wegay) indigenous knowledge as part of their farming practices that have evolved through the course of time without any outside institutional interventions. These technologies are one of the inherited and transferred from generation to generation (Tolera, 2011). The most perceived and preferred indigenous land management practices include zero-grazing, agro-forestry (woodlot), furrow irrigation, trash lines, grass strips, minimum tillage, contour ploughing, animal manures, fallowing and biological or agronomic methods such as cereal-legume intercropping, crop rotation and mulching, residues of crop production (Ayalew*et al.,* 2009).

2.2.2. Introduced sustainable land management practices in Ethiopia

The introduced type of land management technologies refers to the recommended type of structures, which have standard length, width and height. These structures have specific design requirements and need major investments of labor in construction, often during a single period. In most areas of Ethiopia, new land management technologies were introduced more than two decades ago and During such span of time, the introduced technologies have been under continuous modification, which make it very difficult to trace them back to their origins to compare them with recent development (Tadesse, 2011).

The introduced land management technologies in Ethiopia includes soil/stone bunds, bench terrace, inorganic fertilize, check dam, waterways, cut off drains, area closure and closed gullies, hillside terrace, (Shibru, 2010). These technologies are comparatively had long run benefits and importance. However, the hope and desire of the farmers was to get immediate benefits and to increase production from treated lands in order to continue the practical application of the new technology (Aklilu, 2006).

Nevertheless, different studies at different times reached and pointed out those farmers have blamed the new technology. The complains of the farmers are associated with the following drawbacks: its narrowness for ploughing, losses of the substantial lands (out of use), the breeding conditions of rodents and weeds within structure, its difficulty in designing, demands of much labor, encourage for formation of water logging at flat land, solidness at steep slope and artificial water way to form gullies (Eyasu, 2007).

2.3. Significance of the effect of sustainable land management to combat soil degradation

In African drylands, SLM successes were found to include reforestation of degraded lands, harnessing of indigenous knowledge about soil and water conservation, and area development via the rehabilitation of degraded lands (Reij, 2003). Some of the effects of poor land use practices are felt by land users themselves in the form of declining agricultural yields and higher costs to maintain current production levels. It is estimated that land degradation affects approximately 50 percent of agricultural lands on moderate slopes and 80 percent of lands on steep slopes, and that approximately 25 percent of farm households suffer significant soil losses each year, While land users often face constraints in addressing land degradation in their fields, it is somewhat reassuring that over half the farms on moderate and steeper slopes have some form of soil conservation (World Bank, 1997).

Land degradation and its relation to rural poverty remain poorly understood, though the link remains very much in evidence. A downward spiral of land degradation and poverty may be occurring a kind of physical-technical equivalent to the Lewis low-income trap with land degradation causing declining agricultural productivity and worsening poverty, and poverty causing households to further degrade their land. More recently, 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. There is a growing consensus that the effects of past soil conservation programs have been rather disappointing (Bojö, 1996). Although there is evidence of positive effects from conservation measures in some areas, especially within lower-rainfall regimes (Pender and Berhanu, 2004).

Conservation efforts have also neglected the pronounced regional disparities within a given country and have frequently been implemented in a top-down manner, absent the participation of the local communities. For example, research has shown that terracing and several other land management practices can increase productivity fairly quickly by increasing soil moisture retention, and thus are profitable for farmers in lower-rainfall areas of the northern Ethiopian highlands (Pender and Berhanu, 2004).

The same techniques are much less profitable in higher-rainfall areas of the highlands because they can actually reduce farmers' yields by reducing the effective area of the plot, causing water logging, or causing crops to harbor pests (Herweg, 1993). By contrast, the use of fertilizer and improved seeds is much more profitable and less risky in higher-rainfall areas than in lower-rainfall areas, which explains the limited effect of the agricultural extension programs found in lower-rainfall areas (Pender and Berhanu, 2004). compared to very positive effects of the programs found in higher-rainfall areas (Benin, 2006).

Natural resources (land, water, trees, and vegetation), rather than having a single "owner," commonly involve diverse property rights that may be held by different people, including the rights to access, withdraw, manage, or exclude others from a resource and the right to transmit or alienate rights (Schlager and Ostrom, 1992)Conservation and no-till farming can also significantly reduce soil erosion (Pieri *et al*., 2002).

2.4. Soil erosion

Soil erosion has been identified as one of the most pressing resource management problems on the hillsides. In Central America alone, for example, over 60 percent of the hillsides are subject to severe water erosion caused by agriculture. Although an abundance of erosion control technologies exists, adoption of these technologies in tropical countries has been disappointing. In many cases, soil depletion is rational from the farmer's point of view (Ashby, 1985; Anderson and Thampapillai, 1990).

At early stages of soil depletion, the net returns without soil conservation exceed the net returns with conservation. Over time, as soil degenerates further, the gap declines, until eventually net returns with conservation are higher than those without. Adoption of soil conservation technologies is unlikely to occur before this point, which one study calculates to be at least 40 to 60 years after degeneration begins, depending on the discount rate used Seitz *et al* (1979) and this can lead to a conflict between the farmer's logic and ecological considerations. In many cases, adoption of soil conservation practices may in fact occur because of the opportunity to increase income, with soil conservation occurring as a by-product.

This approach derives support from the fact that, in the few cases of successful adoption that have occurred, soil conservation practices permitted the introduction of high-value crops, supported the introduction of livestock, or generated income by being associated with value-added processes (Nimlos and Savage, 1991; Tiffen and Mortimore, 1992).

2.5. Effect of sustainable land management program on livelihood of smallholder farmers

Past studies of the economic costs and benefits of SLM practices (building terraces, bunds, enclosures, etc.) suggest investment in SLM significantly improves agricultural outcomes. However, long-term maintenance of SLM structures is necessary for economic benefits to outweigh the initial construction costs. For example, Schmidt and Fanaye (2014) report an Ethiopian farmer must maintain an SLM structure for at least 7 years before experiencing a significantly higher value of total crop production on their own land. Similarly, Schmidt and Fanaye (2017) suggest that SLM must be paired with other inputs (such as fertilizer and/or improved production technologies), as well as improved connectivity to markets in order to incentivize longer term maintenance of SLM practices.

Estimates of the impact of SLM on agricultural output in Ethiopia are mixed. Pender and Berhanu (2006) conducted a survey of 500 households that invested in stone terraces in Tigray region. They found significantly higher crop yields on plots with SLM compared with plots that did not invest in SLM practice.

Kassie and Holden (2007) found positive effects of SLM on value of total crop production in Tigray and Amhara; however, Kassie *et al* (2009) found that plots with an SLM investment in high rainfall areas of Amhara resulted in lower yields compared with plots with no SLM because of water logging. Araya *et al* (2012) reported that SLM structures must be maintained for an average of 5 years to realize a significant increase in crop yield. Although SLM investments aim to promote agricultural sustainability, studies suggest that maintenance of SLM structures is largely absent over the medium to long term in Ethiopia (Million and Belay, 2004). With the exception of Araya *et al* (2012) previous studies rely on cross-sectional data of specific agricultural plots. Although(Araya *et al* (2012) evaluates SLM investments over time, their analysis is limited to one watershed.

The share of households that had at least one SLM investment on their land increased significantly from 66% to 75% between 2009 and 2013. In particular, stone terraces, soil bunds, and trenches (deeper ploughed areas that siphon excess rainfall runoff away from agricultural fields) increased dramatically. In 2009, 23% and 34% of households reported constructing terraces or bunds, respectively, whereas in 2013, approximately 31% and 48% of households reported using soil bunds and stone terraces on their land, respectively (Schmidt and Tadesse, 2017).

2.6. Causes for the failure of past soil conservation efforts in Ethiopia

Studies carried out in different parts of the country come-up with different factors influence agricultural sustainable land management practices which include capacity of institutions, demographic, farmer attitudes, economic and technology used (Addisu, 2011). The positive attitude of the local farmers ‘towards sustainable land management practices is a favorable predictor for future prevention of soil degradation (Wauters *et al*,. 2010).

3. MATERIALS AND METHODS

3.1. Description of the study areas

3.1.1. Location

This study was conducted in South West part of Ethiopia in Southern Nations Nationalities and Peoples Regional (SNNPR) State of Bench Sheko Zone, Semen Bench Woreda which was found about 566km southwest of Addis Ababa and 802 km from Hawassa, the regional center. Geographically, it is located between 6.74^0 - 7.21^0N latitude and 35.57^0 – 35.75^0E longitude (Figure 1). Semen bench district is covering an area of about 60254.17Km^2. In Semen bench woreda there are 23 kebeles.

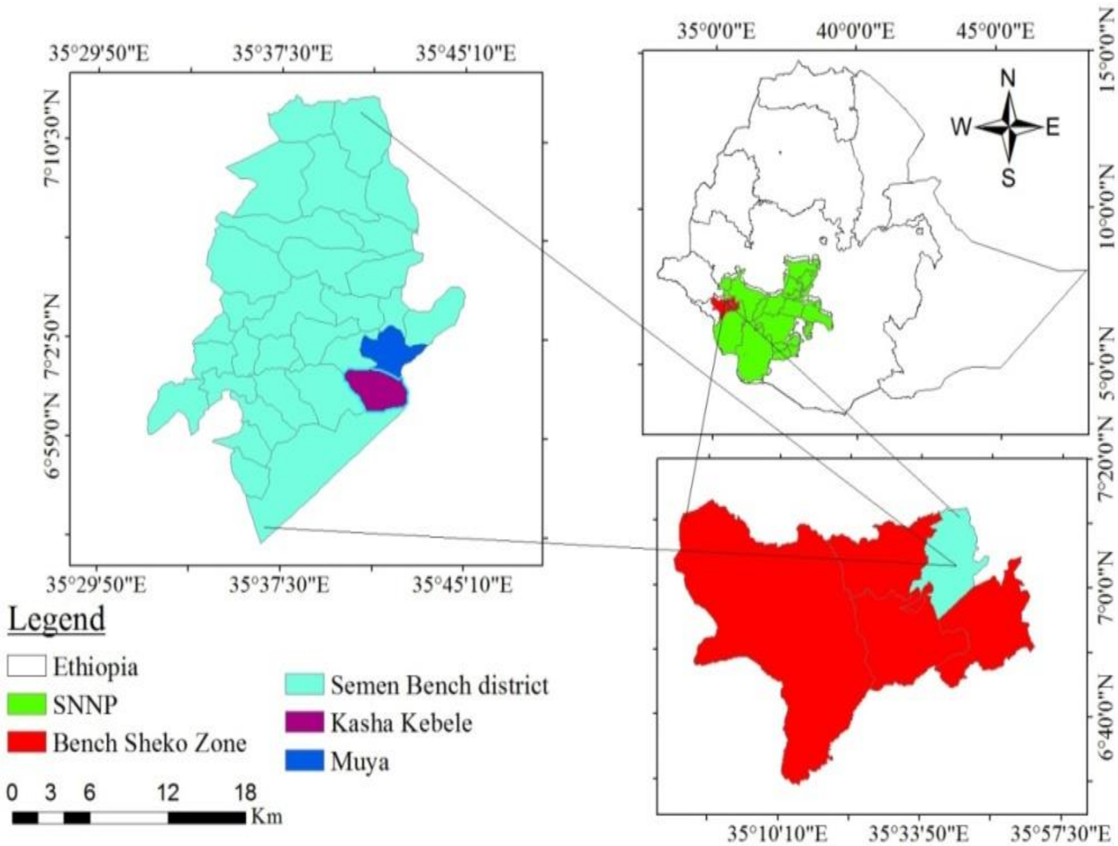

Figure 1: Map of the study areas

3.1.2. Topography and Soil

Topographically Semen bench Woreda altitude ranges 1001-2500m above mean sea level with the spatial distribution of soil types in the study area are sand (32%), clay (34%) and silt (34%) which was clay loam (Tepi Soil Laboratory, 2019).

3.1.3. Temperature and rainfall

The study area has mean annual minimum and maximum temperatures of 15.1 °C and 25.1°C, respectively and the annual rainfall range from 1694.5 to 2252mm which is characterized by one long summer rainy season(Appendices annex 1).

The rainfall pattern of these areas is characterized by unimodal distribution with main rainy season in Kermit.

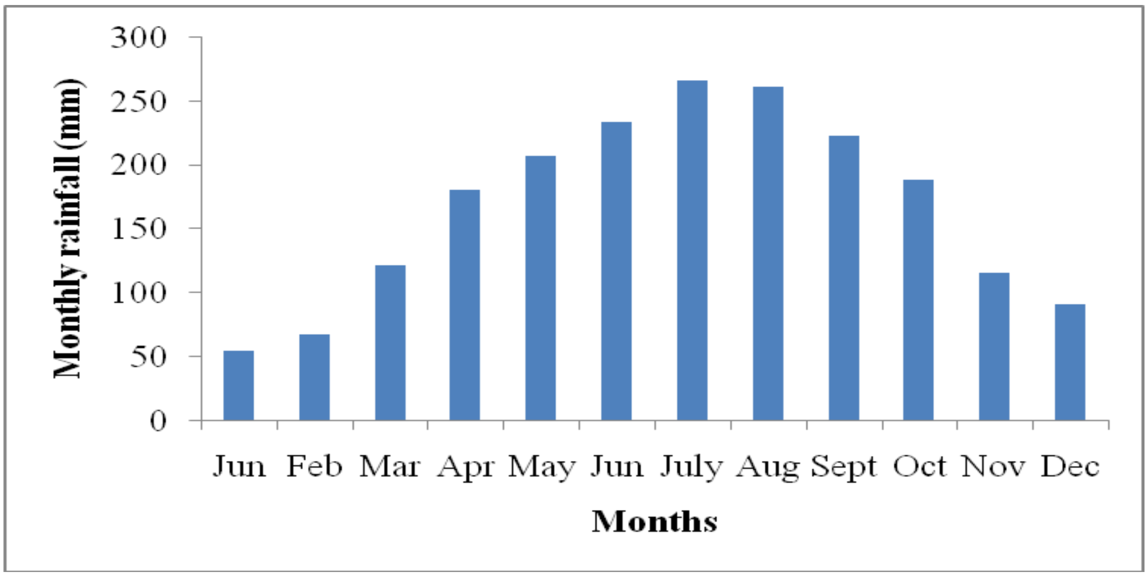

Figure 2: Mean monthly rainfall distribution from 1996 to 2011.

3.1.4. Agriculture, Vegetation and livelihood

The district is characterized by mixed of crop and livestock production system. The major crops produced are cereals (beans, peas, and haricot beans), cash crops (coffee, *chat*, vegetables and fruits) and root crops (Taro, Enset, Sweat Potato). Taro, Maize, sorghum, *teff* wheat, barley and *Enset* are the main food crops. The dominant source of income for the farming community comes from sales of coffee. Besides from sales of fruits such as Avocado, Mango, Papaya, and Banana are also others sources of income next to coffee. The main livestock species reared are cattle, sheep, goats and poultry. About 478,309 (59.5%) cattle; 226,976 (22.3%) sheep and 98,243 (12.2%) goats are estimated to be found in Bench Sheko zone (CSA, 2011). However, the sector is characterized by low productivity and low agricultural technologies, weak linkage between agricultural research and extension, lack of adequate marketing and other infrastructural facilities (BSHZARD, 2012). Land preparation mainly done by man power and ox-drawn plough.

Many indigenous tree species with very limited abundance were found in the area. They are found on some farmer's farmlands, around churches homesteads and the community woodlot. Major indigenous tree species found in the study area are Abalo *(Brucianti discentrica*), Yeabesha Girar *(Acacia abyssinica)*, Weyra *(Olea africana)*, Bisana *(Croton macrostachyus)* and Gesho *(Rahmnu sprinoides)*. Exotics species Nech Bahir Zaf *(Eucalyptus globules)*, Deccurence *(Acacia deccurence)* and Sesbania *(Sesbania sesban)* are also found in the study area.

3.1.5. Soil and Water conservation status in the study area.

Soil erosion is one of the major problems in the area. Since, the area received high rainfall, sheet and rill erosion are common types of erosion and in some areas gullies also observed. The other reasons that facilitated soil erosion are continuous cropping, burning of crop residue, less attention for biological soil conservation practices, and lack of model watershed and different soil conservation measures for demonstration. Expansion of agricultural lands on sloppy land without physical and biological conservation practices is also reported as cause of soil erosion and landslide. Less integration of soil and water conservation practices with agro forestry practices is also another problem (Olkie *et al.*, 2017).

In order to reduce the mentioned problems, farmers practice different biological and physical soil and water conservation measures. The planted of multipurpose grass strips like Vetiver grass, Desho grass along physical soil and water conservation practice like Soil bund, Fanya juu, Bench terrace, Cutoff drains, and waterways (Olkie *et al.*, 2017).

3.2. Sampling techniques and data collection procedures

3.2.1. Sampling techniques

Semen Bench Woreda is found in Bench Sheko administrative Zone. Two kebeles (Muya and Kasha) were purposively selected from the existing 23 kebeles based on coverage and potential of soil and water conservation practices implemented by SLM practices according to data from (Bench Sheko Zonal Bureau of Agricultural, 2014). A total of 138 households (63 and 75 households from Muya and Kasha respectively) were selected randomly for interview. The Sample size determination was done by rule of thumb formula, $N \geq 50 + 8m$ (Green, 1991).

Were,

N = sample size

m=the number of explanatory variables =1, 2…11. To work this research, based on reality of environmental condition of the area and objectives set for this study about 11 independent variables: age, sex, level of education, family size, farmer group, access to DAs, credit service, land owner, land size, distance of farm plot from household residence and slope of land which are sufficient to meet and answer the objectives of this study. The sample size in each kebele was determined by (Yemane, 1967). The current study from 138 households, 87 adopters and 51 households' non adopters were included for interview. (Table 1)

Table 1: Proportional random sampling methods from the total households

Woreda	Kebeles	total households	sample size	adopters	non adopters
Semen	Muya	1190	63 HHs	37	26
Bench	Kasha	1415	75 HHs	50	25
Total		2605	138		

3.2.2. Data collection procedures

All available raw data needed for the current study were collected between (September and January, 2019) by using structured questionnaire, focus group discussions, Key informant interviews, and personal observations to produce primary data, and secondary data was collected from different reports, plans, project reports and documents compiled in Woreda, Kebeles and others sources.

3.2.2.1. Questionnaire

The questionnaire was prepared in English and translated in to local language (Benchigna). For this study, pre–tested 5% of sampled size was taken to check the validity of data then based on pre- test the questionary were re-framed and modified in such a way that households would respond without difficulty and biasness and then distributed to the head of sampled households selected for interview. Interviews were carried out by instructors of Mizan ATVET College and development agents in each kebele. Information collected by questionnaire consists of demographic characteristics of households, effectiveness of sustainable land management practices on crop and livestock production, land degradation, soil and water conservation practiced by farmers, grazing methods, land size, soil erosion and fertility status, major causes of soil erosion, farm input, total income of households, challenge and opportunity for proper land management practices. The questionnaire distributed to sample household heads enabled to generate both qualitative and quantitative data.

3.2.2.2. Key informant interview/KIIs/

Key informant interview involved series of open-ended questions related to the study. For this study about 8 persons from DAs of (agronomist, livestock, natural resource managements), kebeles manager and supervisor of sustainable land management project established in the study area were selected and interviewed, then discussions were made within those experts on major types of crop and livestock, indigenous and improved land management practices their challenges and opportunity and input source in the study area.

3.2.2.3. Field observations

Field observations were carried out during survey work and the whole process of data collection in order to make sure the accuracy of information, based on the understanding of local condition such as land degradation and soil erosion status, grazing methods, farming system and current land management practices conducted by farmers.

3.2.2.4. Focus-group discussions

Focus group discussion was held within selected model farmers, village leaders, village elders and socially respected individuals who are known to have better knowledge on present and past social and economic status of the study area. Number of FGD were two (2) which composed of (10 – 12) members from each kebeles and discussion focused on the history of land management practices; availability of soil and water conservation practices and their challenges and current problem the faced during land management practice.

3.3. Data analysis

To analysis collected data samples of households were categorized in to two adopters and non-adopters. Accordingly, households who used at least two introduced sustainable land management practices from inorganic fertilizer, improved seed, compost, system, modern terrace and soil bund were categorized as adopters and households who practice a maximum of one improved land management practices were categorized as non adopters. Then based on the above criteria, 87 households were identified as adopters and 51 as non-adopters. Then their total income, crop productivity, livestock production, their views on contribution of land management to soil erosion, and soil fertility were compared among adopter and non-adopter of SLM practices. There are various livelihoods but this study was focused on comparing economic livelihood of household income which was generated from land management practices.

Data collected was analyzed using SPSS vs.21 by generating simple descriptive statistics such as percentages, means, standard deviations/standard error, frequency, chi-square and t-test at 5% of significance level. T-test was run to see statistically significant difference in continuous data who adopted introduced SLM practices and those have not adopted more than one. The chi- square was employed to analyzed categorical and dummy data. Index was employed for calculating ranking major causes of soil degradation. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons.

4. RESULTS AND DISCUSSIONS

4. 1. Socio economic and physical characteristics

4.1.1. Sex of respondents

According to Survey result (Table 2) out of the total of sample households, 84.1% in Muya and 81.3% in Kasha kebele were male headed households. The results of current study show that there is no significant difference (p = 0.666) concerning to the sex ratio of respondent among two kebeles.

4.1.2. Age of the respondents

The survey results (Table 2) show that about 31.7% and 30.2% ages of the respondents in Muya were at range of 31-40 and 41-50 years respectively. But in Kasha about 72% were found in age group of 31-50 which means 31-40(36%) and 41-50(36%) years. From this one can conclude that the majority of the respondents were found within the active labor forces that confirm with Central statistics agency of Ethiopia (2007) age ranges from 15-64 are considered to be working age group. This might be makes farmers to participate and adopt agricultural activity which needs more labor. Besides that, the age of sample respondents indicates there was no significance deference between kebele.

4.1.3. Family size

According to this study, household size was a group of persons living together in the same housing unit. The survey result indicates that there was no significant difference in family size in both kebeles. This implies sample of households were relatively contain similar family sizes when compared within kebele.

4.1.4. Educational status

The current survey results (Table 2) indicate that the education level of the respondents was 54% and 46.7% in Muya and Kasha respectively were illiterate which was unable to read and write, 22.7 % got up to grade 4, while the remaining 30.7% attained above 4th grade.
The sample respondents show that there was no significance deference between kebeles at (p=0.462).

4.1.5. Membership to farmers groups

The survey result (Table 2) indicates 50.8% and 52% Muya and Kasha respectively were members of different farmers' group. Through such groupings, agricultural extension officers can gain access to smallholders and share with them new and easily disseminate new information and technologies as well as research findings about benefits of SLMP within the farmers.

4.1.6. Access to extension services (DAs)

The current study indicated in (table 2), extension service was significant at (p= 0.012) within kebeles. Accordingly, household in Muya 58.7 % were more access to extension than Kasha 37.3%. Extension services consists the frequency that the households were contacted and get new information from development agent and other experts related to agricultural profession. This makes the farmer to be more aware to adopt improved and high value land management practices which results in optimal production. As information from household respondents and others, this difference was due to the distance of the household from Woredas capital city and the number of development agent in the Kebele. The dissemination of information on improving technology alternative is an important element that contribute positively for the adoption and sustained use, unless there is no an adequate mechanism for transmitting information about use of any new agricultural practice successful which was confirmed with the result of (Tedele, 2016 and Demeke, 2003).

4.1.7. Agricultural related credit services

The survey result indicated in (Table 2), show that 58.7% of household respondents have got agricultural credit services like inorganic fertilizer, improved seed and improved animal breed in the form of incentives to the farmers in order to encourage them to adopt and maintain SLM practices. As respondent reply, in two kebeles' sources of credit to most households were from SLM project established in study area and governmental organizations. But these types of credits were not sufficiently in amount and timely provided for the farmers which could negative impact on agricultural production in the area. The current study indicates there was no significant difference among two kebeles' with regard to access to credit service.

4.1.8. The Nature of landforms

The current survey result (Table 2) indicates out of the total household respondents 38.1% and 44.4% of the sample household in Muya and 40% and 28% in Kasha kebele were found at steeply and moderately slope respectively. Usually, problem of erosion is so severed in steep slope in high rainfall areas. This idea also rises during FGD to elaborate the effect of the slope is one of the major causes of erosion problem. Therefore, most farmers obliged to undergo different conservation methods in order to cultivate and harvest their crops. The result indicate that the slope of land had no significant difference among the two kebeles at 5% significance level of ($p = 0.064$).

4.1.9. Distance of farm plot from home

According to information obtained from household respondents and FGDs as distance of farm plot increase from home the level of using SLM practice was decrease, because it consumes time to construct and maintain structure from time to time. So increased farm distance was negatively influencing the adoption and intensity of using different agricultural technology. This result was confirmed with the finding of Fikru (2009) and Jabessa (2008) on adoption of soil and water conservation. Generally, there was no significance difference among to kebeles.

4.1.10. Land holding size (ha)

Regarding to land holding size in both kebeles more than household respondents had land size ranges (1 – 2) ha which has similar (table,2) and insignificant across the kebeles.

4.1.11. Land ownership

The current study indicated in (table 2), shows that about 81% and 85.3% of household respondents in Muya and Kasha kebeles respectively had their own land which was similar proportional and insignificant.

Table 2: Socio economic and physical characteristics

Variables		Kebeles				Test	
		Muya		Kasha		$\chi 2$	p- value
		Frequency	%	frequency	%		
Sex						.186	.666
	Male	53	84.1	61	81.3		
	Female	10	15.9	14	18.7		
Farm group						.020	.888
	Yes	32	50.8	39	52		
	No	31	49.2	36	48		
Age categories						3.41	.532
	20-30	14	22.2	8	10.7		
	31-40	20	31.7	27	36		
	41-50	19	30.2	27	36		
	>50	10	15.9	13	17.3		
Family size	Size	HHs				4.0	0.406
	1-2	10	15.9	6	8		
	3-4	22	34.9	31	41.3		
	5-6	16	25.4	20	26.7		
	7-8	13	20.6	12	16		
	>8	2	3.2	6	8		
Level of Edu.						3.61	.462
	Illiterate	34	54	35	46.7		
Grade	1-4	15	23.8	17	22.7		
	5-8	5	7.9	14	18.7		

	9-12	5	7.9	4	5.3		
	>12	4	6.3	5	6.7		
Access to Das						6.3	0.012
	Yes	37	58.7	28	37.3		
	No	26	41.3	47	62.7		
Credit service						.64	.425
	Yes	37	58.7	49	65.3		
	No	26	41.3	26	34.7		
Type of slope						5.49	0.064
	Gentle	11	17.5	24	32		
	Medium	28	44.4	21	28		
	Steep	24	38.1	30	40		
Farm distance						2.74	0.254
	<15min	17	27	20	26.7		
	15-30min	20	31.7	33	44		
	>30min	26	41.3	22	29.3		
Land owner						0.47	0.322
	Yes	51	81	64	85.3		
	No	12	19	11	14.7		
Land size						.74	.980
	0-0.5	3	4.8	4	5.3		
	0.6-1	7	11.1	7	9.3		
	1.1-1.5	13	20.6	17	22.7		
	1.6-2	18	28.6	20	26.7		
	2.1-2.5	12	19	12	16		
	>2.5	10	15.9	15	20		

4.2. Contribution of sustainable land management to rehabilitate degraded land

According to information obtained from FGDs different plant species and animal fodder in ecosystem diminished due to land degradation. This were beginning to restore after the farmers used different introduced SLM practice such as improving soil fertility, grazing land management and other practice to combat land degradation. So, degraded land was gradually converted to grazing and crop land.

4.2.1. Land degradation status

The survey result in (Table 4) indicated that all respondents (100%) within two kebeles knew the problem of land degradation in the area. The farmers faced with different type of land degradation. From that soil erosion, soil acidity and simple landslide were the major types of land degradation that affect agricultural production by diminishing of soil fertility in the study area.

4.2.2. Type of land degradation common to the areas

There was various type of land degradation in the study area, but to simplify this study only three sort of degradation (soil erosion, soil acidity and landslides) which was the most common and major problems that affect land productivity and cause soil degradation in the study area were considered. The current study result in (Table 3) which was collected from household respondents shows that land Degradation due to soil erosion (100%) was the most common and danger for soil productivity fallowed by the problem of soil acidity which share about 28.6% and 28% in Muya and Kasha respectively. Simple landslides in the area were also occurs due to heavy rain fall and slope. The survey result show that within two study area all are insignificance except soil acidity was significance at (p =0.022) this significance might be due to difference level of awareness and knowledge of farmers have on their environments.

4.2.3. Input used to improve soil fertility

The study shown in the Table 3, soil fertility improvement related land management practices were not significantly different across study area. Inorganic fertilizers about 69.8% and 68% in Muya and Kasha were widely applied by the farmers. Organic and inorganic sources of nutrients and agronomic management practices are crucial to improve soil fertility status in general and crop production in particularly. Information collected from household respondents and KIIs tell that, most of poor farmers saw their land without using inorganic fertilizer because of lack of money to buy. Compost, which was the most common organic soil fertility improvement practice, start to be practiced recently year in Ethiopia, which consists of materials from (crop residue, animal manure, other green plants, ash) and animal manure were also practiced in the area to improve soil fertility. From the above soil fertility management practices, compost and crop residues were the least adopted by farmers in study area, because compost needs skill and high man power during preparation and distribution on farm, on the other hand crop residue was used for animal feed during dry season rather than leave it on farm plot for fertility improvements.

4.2.4. Grazing land management practices

The study revealed that the result in (Table 3), indicated the major types of grazing land management practiced which was insignificance between kebeles (figure 3) were control (52.4%, 49.3%), rotational (42.9%, 48%), hay making (39.7%,26.7%) and cut and carry system (9.5%, 16%) in (Muya, Kasha) respectively. Information collected from household respondents show that, since livestock is one of the main livelihood strategies for farmers in the study area to fulfill their basic needs, they might be negative impact on land resource specially during rearing. Because soil degradation was caused by animal trampling, overgrazing and damaging of conservation structure during moving through were one of the main problems to be considered. Therefore, selection of grazing land management practices is a key decision in designing an appropriate land management practice.

Figure 3: Grazing mechanism

Table 3:Distribution of LD status, major type of LD, input and grazing methods

Variables		Kebeles				Test	
		Muya		Kasha		X^2	P-value
		Frequency	%	frequency	%		
Is their LD?	Yes	63	100	75	100	-	-
	No	0	0	0	0		
What are type of LD you faced?	Erosion	63	100	75	100	-	-
	Soil acidity	18	28.6	21	28	7.665	0.022
	Landslide	11	19.3	13	17.3	0.084	0.473
Input used on Farm?	Inorganic fertilizer	44	69.8	51	68	0.054	0.482
	Manure	27	42.9	26	34.7	0.971	0.209
	Compost	10	15.9	10	13.3	0.178	0.427
	crop residues	12	19	17	22.7	0.27	0.38
Grazing Methods?	Rotational	27	42.9	36	48	0.365	0.333
	Controlled	33	52.4	37	49.3	0.736	0.426
	Hay making	25	39.7	20	26.7	2.64	0.075
	Cut and carrying	6	9.5	12	16	1.266	0.192

NB: LD = land degradation

4.2.5. Farmer perception on soil fertility status

Depending on farmer perception on soil fertility status in the area, the following results was obtained by comparing adopters (87) and none adopter (51) introduced land management practices to improved soil fertility. Table 4, showed that farmers which adopt appropriate sustainable land management practice, the soil fertility was improved by 64.4%, other decline (11.5%) due to lack of maintenance of the structures and no change (24.1%) respectively. But in case of non-adopters only 17.6% showed improvement when 52.9% soil fertility was decline. This indicates that the soil fertility status in the study area were improved in case of adopters of introduced SLMP than non adopters. The result indicated soil fertility status was highly significant between adopter and nonadopter of sustainable land management practice at (p = 0.000) due to adoption of improved sustainable land management practices in addition to indigenous land management practices by farmers.

Table 4:Farmer perception on soil fertility

Variable		Kebeles				Test	
		Adopter frequency	%	Non adopter Frequency	%	x^2 value	P value
What is soil fertility over time?						35.84	0.000
	Improved	56	64.4	9	17.6		
	Decline	10	11.5	27	52.9		
	Nochange	21	24.1	15	29		

4.3. Contribution of sustainable land management's to livelihoods of households

4.3.1. Agriculture related livelihood strategies of sample households

From survey result (Table 5), within the agricultural livelihood diversification strategies, three major agriculturally based livelihood strategies mainly crop, livestock and Agro forestry were selected as the major agricultural livelihood. The finding showed that, crop production (34.9%, 29.3%), livestock production (25.4%, 29.3%) and agroforestry, vegetation and root crops (39.7%, 41.3%) in (Muya, Kasha) respectively. According to data from respondents only this type of agricultural livelihood was not enough to ensure food security, because additional option should be needed. The result indicates insignificant across the area.

Table 5:Agricultural related livelihoods within kebeles

Variables	Kebeles				Test	
	Muya		Kasha		$\chi 2$ value	p value
	Frequency	%	frequency	%		
Major Agricultural livelihood					0.551	0.759
Crop production	22	34.9	22	29.3		
Livestock production	16	25.4	22	29.3		
Agro-forestry, vegetation and root crops	25	39.7	31	41.3		

4.3.2. Impact of sustainable land management on major crop and livestock Productions

4.3.2.1. Impact of sustainable land management on major crop production in kuntal

Impact of sustainable land management practices regarding to increasing crop production were analyzed by taking major crop produced in the study area and comparing its mean productivity for adopters and non adopters as shown in (table 5). For this study, sorghum, maize, teff, barley and wheat were selected for study. According to this result, crop productivity between adopters and nonadopters were significant at ≤ 0.05, except for barley, wheat and sorghum and this significant difference might be from sustainable land management practices adoption because land management practices play great role to increase agricultural productivity. Farmers with sufficient crop production also can easily resist sudden crop failures which was confirm with the idea of Conant, (2009) main benefit of using improved crop seed and implementing land management practices is expected to be higher and more stable yields, increased system resilience and, therefore, enhanced livelihoods and food security, and reduced production risk.

Figure 4: Some of main crop produced

Figure 5: Type of livestock’s

4.3.2.2. Impact of sustainable land management on Production of livestock

The current study in (table 6) indicate, the production capacity of livestock between adopter and non-adopter of SLMP in study area were significance for ox, goats and horse, the rest were show insignificant. The reason made this difference might be due to getting of additional feed source from SLMP by integration of different grass (Desho, vetiver and elephant) with Fanya juu terrace structure and used as animal forage to fattening ox, goat and sheep (figure 5) to sell and get additional income. So, the production potential of livestock could be increase with increasing adoption of land management practices.

Table 6:Mean of crop and livestock productions among adopter and non-adopter of SLMP

Variables		Kebeles		Test	
		Mean ±SE Adopter	Mean ±SE non adopter	t-value	p-value
Main crop Productions	*Teff*	2.61± 0.22	1.8± 0.18	2.548	0.012
	Maize	7.33± 0.35	5.24± 0.27	4.145	0.000
	Barley	2.6± 0.21	2.08± 0.14	1.751	0.082
	Wheat	2.52± 0.23	1.98± 0.16	1.68	0.095
	Sorghum	1.86± 0.26	1.16± 0.18	1.899	0.06
Livestock Productions	Ox	2.1± 0.069	1.65± 0.068	4.369	0.000
	Bull	0.57± 0.065	0.63± 0.088	-0.487	0.627
	Caw	1.74± 0.077	1.61± 0.125	0.916	0.361
	Calf	0.62± 0.087	0.53± 0.071	0.726	0.469
	Goat	2.68± 0.186	1.43± 0.184	4.436	0.000
	Sheep	2.63± 0.215	2.98± 0.117	-1.179	0.24
	Chicken	4.9± 0.172	4.63± 0.172	0.879	0.381
	Horse	0.11± 0.034	0± 0)	2.555	0.012
	Donkey	0.16± 0.04	0.18± 0.054	-0.235	0.815

NB: SE=Standard Error

4.3.3. Impact of sustainable land management on housing materials of households

The finding (Table 7) regarding to housing materials 70.1% of households from adopter and 41.2% from non adopter had house with iron sheet which had highly significance. This significance might be due to adoption of SLMP. Because SLMP could be used as source of income and animal feed by planting different variety of grass like vetiver, desho and elephant grass along structures besides to enhancing land productivity by conserving soil from erosion problem.

Table 7:Percentage of housing materials among two categorize of households

Variables	Kebeles				Test	
	Adopter Frequency	%	non adopter Frequency	%	$\chi 2$-value	p-value
Housing materials?					20.336	.000
iron sheet	61	70.1	21	41.2		
grass/bush	12	13.8	25	49		
Other	14	16.1	5	9.8		

4.3.4. Impact of sustainable land management on total income of households

According to the result of household respondents in (Table 8), the mean annual income of adopter and non-adopter was highly significance at (p = 0.000, p = 0.018) in Muya and Kasha which means as adopter earn about 22072.97birr and 18118birr non-adopters earn only 15003.85birr and 151220birr that shows grate variation created due to implementation of introduced SLMP. Survey result show that variation in income between adopters and non adopters within study were due to the advantage that the sustainable land management practices have increased the income of household through increasing crop productivity, addressing challenges of livestock feed availability and combating soil erosion. and moisture stress. The significantly different between adopters and non-adopters might be due to the adoption of sustainable land management practices by households that indicate households who have adopted sustainable land management practices were in better-off position to improve their livelihood than those who have not adopted. It also shows that adopters can be able to afford expensive synthetic fertilizers, improved seeds, keeping livestock and thus uphold their livelihood sustainable which was confirm with idea of Parwada*et al* (2010) and

Tedele (2016) reported that the adoption of land management technologies offer opportunities of improving the quality of the resource for poor farmers.

Table 8:Linkage between sustainable land management and total mean annual income in Birr

Kebeles		N	Mean ± SE	t- value	P- value
Muya				7.763	.000
	Adopter	37	22072.97±613.53		
	non adopter	26	15003.85±645.64		
Kasha				2.424	.018
	Adopter	50	18118±778.78		
	non adopter	25	15120±789.98		

NB: SE=Standard Error, N = frequency of adopter and non-adopter of sample households

4.4. Extent and significance impacts of sustainable land management to reduce soil erosion

4.4.1. Extent of sustainable land managements

According to this current study, extent refers to the coverage and distribution of SLM practice such as agronomic, physical and biological land management practice used in the study area.

4.4.1.1. Physical Sustainable land management practices

Considering the survey result indicates in (table 9), all structures were insignificant in both kebele except cutoff drain at (p = 0.048%). Farmer used indigenous physical sustainable land management practices starting from the ancient year which was transfer from generation to generation but the durability of these structures was very short due to maintenance cost, lack of technical support and damaged by animals and it does not effective to control heavy runoff.

Regarding to use of physical sustainable land management practices, farmers in both kebeles use different practice to reduce soil erosion and increase production. Accordingly, Fanya juu (50.8%, 50.8%), soil bund (30.2%, 22.7%) and counter plough (36.5%, 44%) in (Muya, Kasha) were the dominant physical sustainable land management practices.

4.4.1.2. Biological sustainable land management practices

The results revealed that the adoption rates of vetiver and Desho grass were significance at ($p = 0.024, 0.015$) in Muya and Kasha respectively, but the other practice was insignificance (table 9). This might be caused due to lack of equally distribution of those grass strips across two kebeles by distributer. Farmers used different Biological sustainable land management practices from those agro-forestry was the most dominant practice about 57.1% in Muya and 54.7% in Kasha. Agro forestry includes fruit like papaya, banana, avocado, pineapple and mango were one of the most common in the area was used by household. Agro forestry is not only used economic sustainability by providing increasing crop production but also it conserves plants which are environmentally suitable.

Figure 6: Type of grass strips

4.4.1.3. Agronomic practices

Agronomic sustainable land management practices are integration of both indigenous and improved land management practice which brings a sound full result regarding to production and conserving land resource like plant, soil and water which are basic for human wellbeing. As current study indicated in the (Table 9), farmers used different agronomic practices like fallowing, intercropping and crop rotation by their indigenous knowledge to improve the productivity of their land. From this crop rotation was more adopted than another agronomic based sustainable land management practices in two kebeles about Muya (55.6%) and Kasha (56%) kebele. The result in (table 9) indicated all agronomic practices were insignificant among the study area. Regard to the use of improved crop seed, household survey results indicated that there was problem of getting improved crop seeds. The overall adoption of improved seeds in area was 20% this show that there was low access to improved crop seeds. Due to this problem farmers used one seed repeatedly for many years.

Table 9:Types of SLM practices within Kebeles

Variables		Kebeles				Test	
		Muya		Kasha		$\chi 2$	p value
		frequency	%	frequency	%		
Agronomic Practices	Crop rotations	35	55.6	42	56	0.003	0.547
	Fallowing	13	20.6	10	13.3	1.31	0.179
	Improve seed	12	19	16	21	0.11	0.454
	Inter cropping	18	28.6	17	22.7	0.63	0.275
Physical Structures	Fanyajuu	32	50.8	38	50.8	0	0.562
	Soil/stone bund	19	30.2	17	22.7	1	0.211
	Contour plough	23	36.5	33	44	0.8	0.236
	Cutoff drain	8	12.7	19	25.3	3.47	0.048
Biological Practices	Agro forestry	36	57.1	41	54.7	0.09	0.453
	Vetiver grass	20	31.7	12	16	4.76	0.024
	Desho grass	10	15.9	25	33.3	5.51	0.015
	Elephant grass	13	20.6	14	18.7	0.08	0.469

4.4.2. Contribution of sustainable land management to reduce soil erosion

The current study in (Table 10), indicate that all household respondents 100% perceived the presence of soil erosion in the study area. According to information obtained from households regarding to soil erosion status, the household respondents use different indicators (low harvesting of yield, observing soil color and crop color during growing season, loss of top fertile soil and crop species unable to grow over time) to identify wither their land were affected by erosion or not.

Table 10:Erosion characteristics in the study area

Variable		Kebeles				Test	
		Muya		Kasha		X^2	P value
		frequency	%	frequency	%		
Is their soil erosion?	Yes	63	100	75	100	-	-
	No	0	0	0	0	-	-

4.4.3. Major cause of soil erosion

To analysis this data households were categorized to adopter and non-adopter and identify major cause of soil erosion in two categories. the survey result in (Table 11) indicate that, the primary cause of soil erosion was Excessive rainfall (Index = 0.37) followed by Over cultivation (Index =0.196), Poor farming practices (Index=0.14), Steep slope (index =0.117), Soil erodibility(index=0.025), deforestation (index=0.1) and Overgrazing (index=0.007) in adopter and from non adopter of SLM practice, Excessive rainfall (index = 0.3), Poor farming practices (Index = 0.183), Over cultivation (index = 0.16), cultivation of Steep slope (index = 0.11), soil erodibility (index = 0.025), deforestation (index = 0.24) and Overgrazing (index = 0.003) were lead the main cause of soil erosion in case of non-user of SLM technologies. Human activities such as deforestation, overgrazing, and over cultivation of steep slopes and poor farming practice could be consistently identified as the major cause of soil degradation which was confirmed with idea of (Mushir and Kedru, 2012).

Table 11:Ranks of major cause of soil erosion among adopter and non-adopter of SLMP

	Ranks							
Variables	Adopter				Non adopter			
	Rank1	Rank2	Rank3	Index	Rank1	Rank2	Rank3	Index
Overgrazing	-	-	4	0.007	-	-	1	0.003
Deforestation	10	9	8	0.1	15	17	20	0.24
Over cultivation	4	32	35	0.196	1	16	28	0.16
Poor farming practices	19	12	10	0.14	12	15	8	0.183
Excessive rainfall	51	24	7	0.37	28	13	4	0.30
Soil erodibility	-	14	14	0.074	-	2	6	0.025
Cultivate of slope	13	5	17	0.117	10	5	4	0.11

4.4.4. Household perception on severity of erosion and change of farm size over time

4.4.4.1. Farmer perception on severity of erosion

In order to determine the effect of SLM practice on erosion, there was the need of categorize household to adopter and non adopter of these technology as mentioned in methodological section. According to information from household respondents, the main causes of soil erosion in the study area was soil erosion due to excess rainfall, deforestation and poor farming practice especially for non-adopter of sustainable land management with (index =0.300, 0.24 and 0.183) respectively. If soil erosion is controlled, farmers were with sufficient production and can also get sufficient food during food shortage. Sample households were asked their opinion on the severity of soil erosion on their productive land. Regarding to farmer perception on severity of soil erosion (table 12) about 52.9% adopters believed soil erosion become low over time and was highly significant between adopters only 7.8% and non-adopters. This significant difference might be due to use of SLMP.

4.4.4.2. Impacts of sustainable land management on the size of productive farm land

The result in (Table 12) shows that, there was highly significance among two categorize of adopter and non-adopter. Regarding to changing size of farm land over time, the respondent reflects two contradict ideas. The 1st ideas suggested that farm size was increased due to use of SLM practices. Because degraded land was conserved and changed to productive land. The 2nd

ideas explain that land used for cultivation was minimized by conservation structure and land left near to structure due to different factors. The 2nd ideas were almost related with farmers holds small land size and farmers that couldn't use introduced SLMP and farm size decrease by erosion problem, where as the 1st ideas confirm with farmers who holds large farm size and impalements introduced land management technologies. This variation might be due to adoption of introduced SLM practice on their land.

Table 12:Erosion severity and change of farm size by households

		Kebeles				Test	
Variables		Adopter Frequency	%	non adopter frequency	%	$\chi 2$-value	p-value
Severity of erosion?						43.909	.000
	High	12	13.8	33	64.7		
	Medium	29	33.3	14	27.5		
	Low	46	52.9	4	7.8		
Size of farm over time?						73.539	.000
	Increase	64	73.6	1	2		
	Decrease	23	26.4	36	70.6		
	no change	0	0	14	27.5		

5. SUMMARY AND CONCLUSION

5.1. Summary

This study was conducted with the objectives the impacts of SLM practice on rehabilitation of degraded land, soil erosion and livelihood of households in Semen Bench Woreda, Bench Shako Zone, South Ethiopia. The finding of the study revealed that, this area was affected by different kinds of land degradation. To rehabilitate degraded land, farmers in the study area were used different SLMP such as grazing mechanism and farm land management. Control (52.4%, 49.3%) and rotational grazing (42.9%, 48%) mechanism were highly used to control land degradation caused due to grazing problem by farmers in Muya and Kasha kebele respectively. The main causes of soil erosion in the study area were soil erosion due to excess rainfall, deforestation and poor farming practice especially for non-adopter of sustainable land management with (index =0.300, 0.24 and 0.183) respectively. If soil erosion is controlled, farmers were with sufficient production and can also get sufficient food during food shortage. Regarding to farmer perception on severity of soil erosion (table12) about 52.9% adopters believed soil erosion become low over time and only 7.8% non-adopters become lower. This significant difference might be due to use of introduced SLMP.

The findings of the study related to changing of the size of farm land over time, the farmers reflect two contradict ideas. The 1st ideas suggested that farm size was increased due to use of SLM practices, which means degraded land was changed to productive land. The 2nd ideas explain that land used for cultivation was minimized by conservation structure and land left near to structure due to different due to structure. The result revealed that 73.6% adopters and

70.6% non-adopters showed increased and decreased respectively. To improve soil fertility farmers used different organic and inorganic fertilizer as inputs on their productive land. Table 4, showed that farmers which adopt appropriate sustainable land management practice the soil fertility was improved by 64.4%, decline (11.5%) due to lack of maintenance of the structures and no change (24.1%) respectively. But in case of non-adopters only 17.6% showed improvement when 52.9% soil fertility was decline. This indicates that the soil fertility status in the study area were improved in case of adopters of introduced SLMP than non-adopters.

Regarding to total annual income, the farmers that adopted improved SLM practice on their farm land were economically more productive than others. For example, as adopter earn about 22072.97birr and 18118birr in Muya and Kasha, non-adopters earn only 15003.85birr and 151220birr that shows grate variation created due to implementation of introduced SLMP. According to survey result, due to introducing of land management practice the availability of forage used for animal feed, awareness of farmers on land degradation, and soil erosion were improved but it doesn't enough. Most of the SLM practices are complementary to one another, and practicing of two or more SLM practices in a given plot was found to be highly associated with higher value of crop production but almost all farmers did not used an integrated SLMP. More importantly, a considerable increase in value of crop production was observed in plots which are treated with multiple SLM practices. This may also encourage extent and rate of using multiples practices in rural households to conserve their plots. To improve this, planners and policy makers should formulate appropriate programs considering the farmers interest, capacity, and limitation in promoting multiple use of improved sustainable land management practice/ technology for greater acceptance and adoption by the farmer to enhance their land productivity.

5.2. Conclusion

The general finding of the study indicates that different sustainable land management activities were being practiced in order to conserve land resource and to maximize agricultural production and simultaneously control soil erosion. Even if these efforts were made by government and NGOs, the problem of soil degradation and full package implementations of SLM program were not totally solved yet as expected.

5.3. Recommendation

- Awareness should be given for farmers on integrated use of SLM practice
- Attention should be given on practical based training rather than theory for the farmers by concerned body such as extension workers and other institutions working on land resource conservations.
- To improve the productivity of the farmland focus should be given to intensive technique of agricultural system that promote the use of various soil fertility improvement and conservation practices to boost production from small plot of land. In addition, female should be encouraged to put manures on farm fields rather than lost as waste products at unwanted area.
- Farmer training center (FTC) should be constructed at a site to give training for the farmers.
- Since due to the day-to-day life of farmers in the study area is more based on crop

production and livestock, in some extent it is possible to incorporate small poultry production, apiculture and fish farm for ensuring food security in addition to income source for farmer because they are environmentally friendly.

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APPENDICES

Annex 1: Structural survey questionnaire

A. Demographic characteristics

1. Name of respondent________________________________

2. Address of respondent

3. Location: ______________________________________

4. Sub-Location_____________________________________

5. Village: ______________________________________

6. Sex: 1) male 2) female

7. Marital status 1) married 2) unmarried 3) divorce 4) other

8. Age: 1) 20-30 year 2) 31-40 year 3)41-50 Years 4) 51-60 Years 5) Over 61Years

9. Educational status: 1) illiterate 2) 1-4 3) 5-8 4) 9-12 5) Other

10. What is your average income per year in birr? __________

8. Do you think that engagement in SLMP on your farm would be an important measure in improving your income level? 1. Yes 2. No

9. What is the size of your land in hectares?

1= 0.5	4= 1.6-2
2= 0.6- 1	5=2.1-2.5
3= 1.1-1.5	6 > 2.5

10. Do you belong to any farmers group? 1. Yes 2. No

B. Sustainable land management practices

11. Is your farm affected by land degradation? 1. Yes 2. No

12. If yes which form(s) of land degradation do you face? 1. Soil erosion 2. Soil acidity

3. Simple landslides 4. Other (Specify)

13. If yes which one of the following is the major cause of soil degradation? give rank for them?

1. Deforestation ____________
2. Over grazing ____________
3. Over cultivation _________
4. Poor agricultural practices ________
5. Cultivation of steep slopes _______
6. Excess rainfall __________________
7. Poor government polices _________
8. Others (specify) ____________________

14. Do you use soil and water conservation practices on your land? 1. Yes 2. No

15. If answer for question 14 is yes, which SWC measure you use? (More than one answer is possible)

Type of soil and water conservation practices used

Items	Select
Crop rotation ________________	
Adding plant residue__________	
Drainage ditches______________	.
Strip cultivation______________	
Fallowing________________	
Contour farming______________	
Stone/Soil Bund____________	
gabion______________	
Cut of drain___________	
Agro forestry___________	
Vetiver grass_____________	
Desho grass_____________	
Elephant grass_______________	
Fanya juu Terrace and other_____	
Inorganic fertilizer__________	
Manure __________________	
Compost _________________	

Crop residue ____________

16. What is the importance of SLM practices for your farming?

1. Reduction of soil erosion 2. Conservation of water Improve 3. Soil fertility

4. Improve agricultural productivity 5. Other (Specify) ______________

17. What are the determinant factors of land management practices in your area?

1. Topography 2. Vegetation/forest removal

3. Shortage of arable land 4. Lack of awareness

C. Income of households

18. What are your major agricultural livelihoods?

1. Crop productions 2. Livestock productions

3. Agroforestry, vegetation and root crops

A) Agricultural productivity

19. List the major crops you produced in a year

Main crop produced

Crop	Total production (kgs, bags)	Farm input cost (birr)
Teff		
Maize		

Barely		
Wheat		
Sorghum		
Total		

20. In your opinion do you think that SLMP application can enhance your land productivity?

1) Yes 2) No

21. What is the distance of your cultivation field from your residence?

1) Less than 15 minutes

2) 15-30 minute

3) over 30 minutes

22. How do you see the size of agricultural land over time?

1. Decrease

2. Increase

3. No change

23. Have you your own land? 1. Yes 2. No

24. How do you notice the fertility of your land?

1. Improving

2. No change

3. Declining

25. If the fertility of your cultivation land is declining, what are the indicators?

1. loss of top fertile soil

2. low harvesting of crop yield
3. loss of endemic plant species
4. change of soil color
5. change of crop color

26. If it is declining, what measures do you apply to enhance the fertility status of your land? (More than one answer is possible)

1. Application of commercial fertilizer
2. Animal manure
3. Compost 4. Crop residues 5. Improved seed 6. other

27. How do you see the productivity of your farm land overtime?

1. Decreasing 2. Increasing 3. The same 4. I don't know

28. How do you describe the slope of your cultivation land?

1. Gently 2. Moderately 3. Steeply

B) Livestock production

29. Describe the livestock you own

Type and number of livestock

Livestock type	Total number
Cow	
Calf	
Ox	

Bull	
Goat	
Sheep	
Poultry	
Horses	
Donkey	

30. What method used grazing land management?

1. Rotational 2. Control

3. Hay making

4. cut and carrying system 5. Free grazing ___________________

31. How do you describe the trend of animal feed?

1. Declining 2. Increasing 3. The same

32. What are your housing materials (roof top)?

1) Iron sheet 2) grass/bush 3) other

D. Institutional supports

33. Do you have access to DAs (extension service?) 1. Yes 2. No

34. What facilities and supports that you need from government and other body to manage your land? ____________________

35. Where did you get information about SLMP practices?

1. Traditionally (learn by self)

2. from DAs

3. from NGOs

4. From neighbors

5. Other source specify

36. Did you take any credit for purchase SLMP on your farm? 1. Yes 2. No

37. If yes, from which source did you borrow? 1. Bank Cooperatives 2. Private money

3. Lenders 4. Others (Specify)

E. Farmer perception of soil erosion problems

38. Do you think soil erosion is the problem of this area? 1) Yes 2) No

49. What do you think is the consequences of soil erosion?

1. Land productivity (yield) decline 2. Reduces farm plot size

3. Change in type of crops grown 4. Reduce soil fertility

F. Perception on erosion

41. Is soil erosion was the problem on your farm land? 1) Yes 2) No

42. If your answer on question 41 was yes, how you describe severity of soil erosion

1) High 2) Moderate 3) Low

43. What was soil erosion severity over the past years?

1) Has become more severe

2) Has become less sever

3) No change

44. What Extent of impact of soil erosion on farm production

1) High

2) Moderate

3)Has no effect

45. Could you believe soil erosion can be controlled? 1) Yes 2) No

Annex 2: Key informant Interview

1. What are the major types of food crop grown in your kebele______________?

2. What are the major types of livestock in the kebele _________________?

3. What are indigenous land management practices do the local community practice on different land use like farm land, grazing land and other?

4. What are the constraints regarding to traditional land management practice?

5. By what criteria does the local community select each land management practice?

6. What are modern land management practices implemented in your area?

7. How you describe each land management practice regarding to reduction in soil erosion, crop production, forage and income diversification?

8. Is there any wildlife come to their original home due to implementing land management practice that migrates due land related problem? If yes please list them

9. What you thing the challenge for effective land management practice and also what are the

best remedies?

Annex 3: Focus Group Discussion

1. What are land management practices you have been using to increase your production?

2. What are the criteria that you use to select land management practice?

3. What are the major livelihood strategies in your area?

4. Do you really believe that land management has impact on the livelihood of the community?

5. What are the main challenges and opportunities regarding to LMP?

6. What are the sources of inputs required for land management?

Appendix Table:

Annex 1: Annual and Monthly rainfall of Bench Sheko Zone (1996-2011)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1995	0.2	38.4	77.8	141.9	218.5	210.4	190.6	306.1	291.7	198.4	129.4	235.8	2039.2
1996	79.4	33.2	135.7	172.2	159.6	387.1	227.4	283.2	284.6	171.5	74.3	56.3	2064.5
1997	46.5	67.7	163.2	325.5	218.8	199.0	232.1	203.0	262.9	149.4	267.7	79.8	2215.6
1998	80.8	45.3	170.1	245.5	178.6	221.2	263.0	278.9	215.2	246.1	88.8	34.9	2068.4
1999	62.6	75.3	112.2	280.8	267.9	187.0	295.6	310.2	230.0	276.0	70.2	84.2	2252.0
2000	22.2	76.0	79.5	161.3	246.7	221.0	400.4	271.3	132.6	253.4	86.3	24.4	1975.1
2001	26.5	49.3	129.3	148.5	206.0	234.0	257.0	286.0	143.0	216.7	87.3	113.4	1897.0
2002	83.3	43.7	134.1	137.2	126.1	225.1	249.5	197.5	126.4	201.3	68.9	111.1	1704.2
2003	32.7	48.7	116.4	222.8	111.8	320.7	178.5	310.8	275.2	138.5	115.7	104.3	1976.1
2004	31.2	44.1	49.3	266.1	386.0	142.9	253.5	278.6	213.3	145.9	123.4	116.2	2050.5
2006	35.4	83.8	150.0	130.8	220.6	278.9	133.3	452.9	226.8	164.8	200.1	112.5	2189.9
2007	74.6	68.8	104.9	205.7	267.0	234.2	378.5	245.5	256.1	147.2	96.6	121.3	2200.4
2008	36.1	43.1	125.1	154.2	189.5	173.5	409.4	156.6	273.1	157.5	56.7	121.3	1896.1
2009	26.0	95.4	168.0	109.0	119.0	188.0	257.0	238.0	213.3	169.0	190.7	45.7	1819.1
2010	131.0	121.6	81.0	66.0	95.9	272.6	298.4	156.0	219.0	228.0	11.0	14.0	1694.5
2011	107.3	143.8	159.2	130.8	315.5	246.4	233.3	212.6	216.8	164.8	190.0	87.6	2208.1
Total	875.8	1078.2	1955.8	2898.3	3327.5	3742.0	4257.5	4187.2	3580.0	3028.5	1857.1	1462.8	

Source: - Jimma Meteorological station, 2012

BIOGRAPHICAL SKETCH

The author of this thesis, Mr. Kenbon Abera Keneni, was born on October 5, 1993 in West Shewa Zone of Oromia Regional State, Ethiopia. He attended his primary and secondary school at Reji and Mogor respectively from (1999-2010). Then joined Wollega University in 2011 and awarded a BSc degree in Soil Resources and Watershed Management in June 2013. After his graduation, he was employed by the Ministry of Agriculture and served in Mizan Agricultural Technical Vocational Educational Training College (ATVET), SNNP Regional State of Ethiopia and worked as an **Instructor** of Soil Resources and Watershed Management. In 2018, he joined the School of Graduate Studies (SGS) of Hawassa University to pursue his M. Sc study in Soil and Water Conservation Engineering.