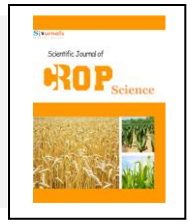
Sjournals

Scientific Journal of Crop Science (2015) 4(1) 1-27
ISSN 2322-1690
doi: 10.14196/sjcs. V4i1.1817

Contents lists available at Sjournals

Scientific Journal of CROP Science

Journal homepage: www.Sjournals.com



Original article

The effect of sustainable land management (SLM) to ensure food security; local evidences from Tehuledere Woreda, ANRS, Northern Ethiopia

M. Yimer

Arba Minch University, Arba Minch, Ethiopia.

*Corresponding author; Arba Minch University, Arba Minch, Ethiopia.

A R T I C L E I N F O

Article history,
Received 03 January 2015
Accepted 19 January 2015
Available online 27 January 2015

Keywords,
SLMT
Food security
Tehuledere woreda
Ethiopia

A B S T R A C T

Now a days, land degradation has emerged as a significant threat to the promotion of green economy, wellbeing of the ecology and ensuring food security. To counteract such a problem, Scaling up SLM technologies is a drastic solution. It is with this grand theme that this study was conducted in Tehuledere Woreda in three surrounding districts (Amumo, Kundimeda and Messal) taking the vulnerability of the area in to consideration. It shade light at identifying the factors hindering the adoption of SLM technologies and, the role of SLM technologies to ensure food security, and assessing the causes of food security in the context of SLM in the study area. The data used were obtained from both primary and secondary sources. The primary sources include structured questionnaire survey and focus group discussion methods. A total of 193 households were interviewed and their responses were interpreted. Scientific reports and conference proceedings were used to support the primary data. Descriptive statistics method was used for analyzing among farm land size, household, topography, erosion status and the adoption of soil and water conservation practices. The results indicated that farm land size, educational status of household head, slop of the farm land, lack of awareness, lack of adequate rain fall, financial constraints and distance to the farm plot from household home were among the major factors that negatively influence adoption of SLM in the study area which resulted in food insecurity. Furthermore, applying cost effective technologies which are suited for different topography such as manure, stone bundles, check dams, planting trees, etc. are recommended to be adopted effectively to ensure food security. Finally, lack of rainfall, land degradation and soil erosion, small land size, and limited status of SLM technologies are found to be causes of food insecurity in the context of SLM. As land is the main stay of the life in rural areas, efforts should be exerted for successfully scaling up of SLM technologies.

1. Introduction

1.1. Background of the study

The Ethiopian economy has its foundation in the agricultural sector. This sector continues to be a fundamental instrument for poverty reduction, food security, and fueling economic growth. However, the sector continues to be undermined by land degradation in the form of depletion of soil organic matter, soil erosion, and lack of adequate plant-nutrient supply (Pender et al., 2006). There is evidence that these problems are getting worse in many parts of the country, particularly in the highlands of Wollo. Furthermore, climate change is anticipated to accelerate land degradation in Ethiopia. Over the last few decades, as a cumulative effect of land degradation, increasing population pressure, and low agricultural productivity, Ethiopia has become increasingly dependent on food aid. In most parts of the densely populated highlands, cereal yields average less than one metric ton per hectare (Pender and Gebremedhin, 2007). Such low agricultural productivity, compounded by recurrent problems of famine, contributes to extreme poverty and food insecurity.

Increased adoption of improved technologies remains the key to achieving food security in Ethiopia, where agriculture is mainly characterized by little use of external inputs, low productivity, high nutrient depletion, and soil erosion that limit farmers' ability to increase agricultural production and reduce poverty and food insecurity (Kassie et. al 2008, 1). Over the last three decades, the government of Ethiopia and a consortium of donors have invested substantial resources to develop and promote sustainable land management (SLM) practices as part of efforts to improve environmental conditions, ensure sustainable and increased agricultural production, and reduce poverty. However, due to low rates of adoption, most of the promoted practices have been only partially successful. In some cases, dis-adoption or reduced use of technologies has been reported (Tadesse and Belay, 2004).

With the geo-climatic condition, inherent soil fragility, undulating terrain, and highly erosive rainfall Ethiopia has continually faced challenges in conserving its soil fertility. Coupled with these natural constraints, the environmentally destructive farming methods that many farmers practice make the country highly vulnerable to soil erosion. Moreover, some sources estimate that close to one-third of the agricultural land is moderately to strongly acidic because of long neglect in soil conservation and destructive farming practices. Gully formation and sedimentation at the river banks, dams and irrigation channels are extensive.

Sustainable land management (SLM) has 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 land and water resources is accelerating rapidly in many countries in general and Ethiopia in particular.(Mitiku, 2006)

Land degradation is an alarming challenge in the Amhara region where erosion is the main cause of the loss of approximately 2 to 4 billion tons of soil annually leaving between 20,000 to 30,000 hectares of land unproductive (Taffa, 2009). Although natural factors are to some extent the cause for environmental degradation, coupled with the effects of a long history of settlement, prevailing farming methods and increasing population pressure which forces people to cultivate even steeper slopes have exacerbated the devastating land and resource degradation in the region (Belay, 2010). The poverty in the Amhara region is still high (7.3 million) next to Oromya (9.3 million) although the latter shares the largest population size compared with other regions (DPRD & Mo FED, 2008). 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 (Gisladottir and Stocking, 2005; Campbell and Hagmann, 2003).

At the national level, the Government of Ethiopia introduced a series of policies and institutional reforms to address these complex and diverse issues. Along with other initiatives, the Sustainable Land Management (SLM) program through the Sustainable Land Management Project (SLMP-I which has been operational between 2008/09 – 2012/13) has made progress in introducing sustainable land management practices in the country. The SLMP-I has made remarkable progress in rehabilitating targeted degraded areas, soil stabilization works.

Land degradation is widespread and increasing in northern Ethiopia, particularly in South Wollo. Available knowledge towards SLM unfortunately, remains concentrated at isolated "islands of successes" and largely fragmented in terms of adoption/ uptake (www.worldagroforestry.org). Although individuals and institutions recognize the need for wide adoption of SLM innovations, the inhibiting challenges including: (i) long time to realize benefits;(ii) low rates of returns to investments; (iii) lack of incentives for collective action; and (iv) lack of mechanisms to translate development strategies and policies into effective implementation of SLM at landscape levels.

While good land management is important at the field and farm level, it is not enough to ensure sustainability. The planning and execution of sound sustainable land management at the watershed (catchment) level and even beyond (often referred to as the "land scape level") is increasingly important for retaining ecological balance and integrity which in turn is indispensible for ensuring food security while avoiding degradation of land and water resources in the contrary (FRP 2005). New scientific knowledge detailing the extent and importance of ecosystem services and their roles in sustaining humans and our agro-ecosystems is now becoming available. The social and economic values of these services provide new opportunities for policies to encourage SLM. Recent advances in remote sensing tools will greatly facilitate the timely monitoring of land management effects and resource degradation by both users and policy makers. However, new investments will be necessary to meet the demand from land users to (a) improve access to existing knowledge and information of SLM and the consequences of inappropriate management, (b) appropriately intensify land use, and (c) rehabilitate land that has been degraded for both productive and ecosystem functions.

SLM is defined as 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. SLM is necessary to meet the requirements of a growing population. Improper land management can lead to land degradation and a significant reduction in the productive and service functions. In layman's terms, SLM involves:

- Preserving and enhancing the productive capabilities of land in cropped and grazed areas that is, upland areas, downslope areas, and flat and bottom lands; sustaining productive forest areas and potentially commercial and noncommercial forest reserves; and maintaining the integrity of watershed for water supply and hydropower generation needs and water conservation zones and the capability of aquifers to serve the needs of farm and other productive activities.
- Actions to stop and reverse degradation or at least to mitigate the adverse effects of earlier misuse, which is increasingly important in uplands and watersheds, especially those where pressure from the resident populations are severe and where the destructive consequences of upland degradation are being felt in far more densely populated areas "downstream."

The requisites of successful SLM do not operate in isolation from other environmentally strategic interventions. For example, SLM will clearly overlap with, and to some extent be dependent on, progress in improving the sustainability of agriculture, as well as associated soil conservation efforts; responsible water management; and accountable livestock management and reduced impact logging practices. However, there are manifestly important aspects of SLM that singularly pertain to the most significant land issues, namely sustaining soil productivity and averting land degradation.

The causes of the more obvious kinds of degradation have been fairly well documented. These causes whether the result of population pressure, deforestation and abuse of forest margins, disregard (or ignorance) of the environmental consequences stemming from the dominant crop-livestock system, or industrialization and urbanization can be grouped, in general terms, into three categories: These are a)Those owing to chemical and physical processes resulting from interaction between the prevailing agricultural and industrial technologies and the surrounding land resource base.b) Those of a grander or "macro" nature, such as global warming or volcanic eruption, whose consequences can be anticipated even if the onset of damage cannot be forecast with precision. c) Those whose roots are behavioral whether deliberate and thus the result of improper private incentives ultimately linked to market failure or stemming from lack of knowledge or from technologies.

The implication of all these human activities on the land and the consequence of land degradation are obvious. It resulted in the house hold food insecurity in the surrounding area. This is because, for the agricultural households, land is more than just a factor of production in which almost all the people are dependent on it for food. (Sandesh, 2008)

1.2. Statement of the problem

In Ethiopia, the seriousness of the food shortage problem varies from one area to another depending on the state of the natural resources and the extent of development of these resources. According to various sources, some 42 periods of food shortages (including the 1999 and 2000 food shortages) have been recorded in Ethiopia (Webb et al. 1992), most of which were concentrated along two broad belts, generally described as drought and famine prone areas. One of these is the mixed farming production system area of highland Ethiopia, involving central and northeastern highlands stretching from Northern Shewa through Wollo into Tigray. The land resources mainly the soils and vegetation of this part of the country have been highly degraded because of the interplay between some environmental and human factors such as relief, climate, population pressure and the resultant over-cultivation of the land, deforestation of vegetation and overgrazing. The second belt is the range-based pastoral economy of lowland Ethiopia, ranging from Wollo in the north through Hararghe and Bale to Sidamo and Gamo Gofa in the south. Apparently, this belt is generally considered as resource poor with limited potential and hence highly vulnerable to drought. Therefore, it is this vulnerability of the study area that initiates the researcher to explore the issue of SLM practices and the potential impact on the food security status of the farm households.

The other focus on the implication of SLM to ensure food security is justified by the overwhelming reliance of Ethiopian economy on land based resources. The population of the country which constitutes the lion share of the total population is dependent on land for food, in which otherwise is life becomes impossible. Therefore, land should be properly and sustainably managed to prove food security which is consistent enough with the country's policy of promoting pro-poor growth in its quest to sustainable development. Furthermore, the country's leading export items as of today are dominantly the direct products of land-based resources.

Thus, the study focuses on SLM practices and its implications for ensuring food security in Tehuledere Woreda, South Wollo zone, Northern Ethiopia. Provided that land plays an important role in supporting the livelihoods of the majority of people involved in agriculture, food security and poverty reduction cannot be achieved unless issues of access to land, security of tenure and the capacity to use land productively in a sustainable manner are addressed. The rural agricultural households who are the primary producers of food have often been found to be food insecure mostly due to poverty which has a close connection with unsustainable land management and consequent land degradation .It is the central objective of this study to show the negative impact of such a degraded land to ensure food security to the rural poor of the country in general and the selected study area, Tehuledere Woreda, in particular.

Tehuledere Woreda is characterized by high rates of land degradation, low land productivity, proneness to drought, and chronic food insecurity. The population of the area is highly dependent on food aid as a result of the poor management of land which is the main stay of the society residing in the surrounding area.

1.3. Objectives of the study

1.3.1. General objective

The general objective of the study is to show the implication of Sustainable Land Management on food security in Tehuledere Woreda, South Wollo Zone. This consequently entails generating practical, context-specific recommendations for SLM approaches and practices that are suited to ensure food security in the study area.

1.3.2. Specific objectives of the study

1) To find out the major constraints to Scaling up SLM Practices in Tehuledere Woreda.

2) To explore the role of SLM to ensure food security in the study area.
3) To examine the major causes of food insecurity in the context of SLM in the study area.
4) To assess the prospects of SLM in the Woreda.

3. Methodology

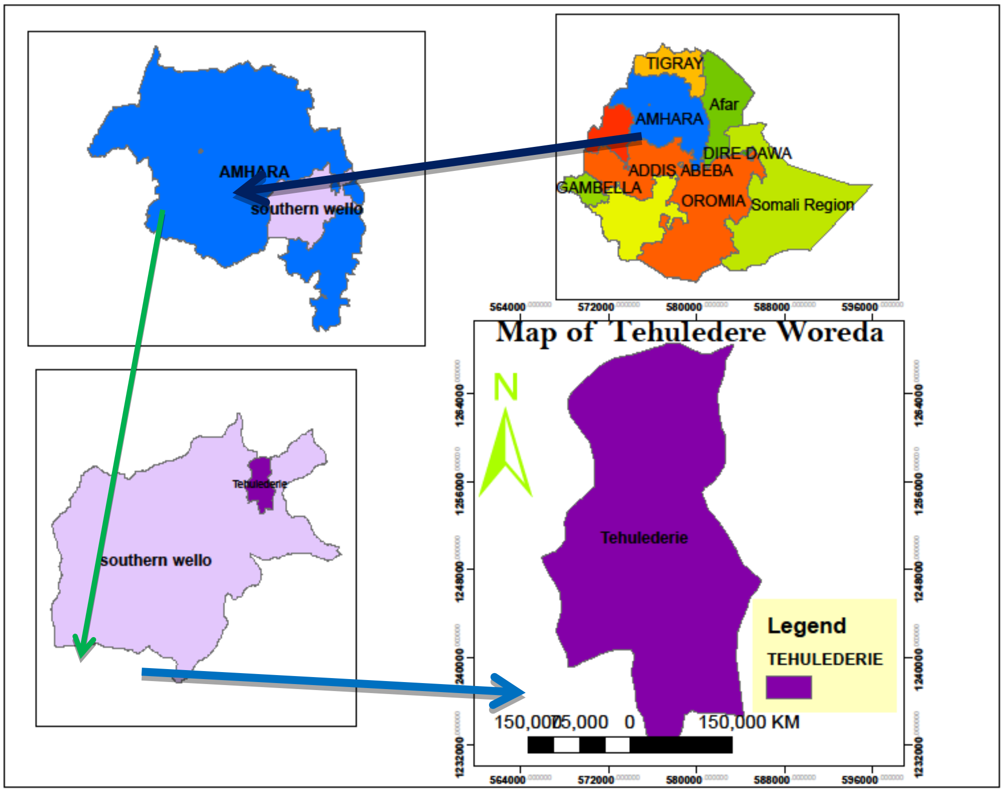
3.1. Description of the study area

As it is repeatedly stated in the previous sections, the study is going to be conducted on the implication of sustainable land management in ensuring food security in Tehuledere Woreda, South Wollo zone.

Tehuledere Woreda is one of the twenty two districts of South Wollo in the Amhara National Regional State. The Woreda is located at a distance of 430 km from Addis Ababa on the main road to Mekele. It shares immediate boarders in the North with Ambassel Woreda, in the South with Dessie Zuria Woreda, in the East with Worebabo Woreda and in the west with Kutaber and Ambassel Woreda.

The capital city of the Woreda, called Haik is located at a distance of 30km from Dessie. The Woreda has a total area of 44,030 hectares and subdivided into nineteen rural and five small urban kebeles. It has different Agro-ecological Zone varies from Dega to Kolla. Dega covers 13% Woyina Dega 72% and Kolla 15%. Its average annual rain fall is 1030 mm and has average temperature of 21oc per annum. According to the recent Woreda population report, 152891 is the total population of the Woreda. The total number of agricultural households is 25380, of the total rural households, 20884 are male and 4496 are female households. Out of the total land cover, 15937 ha are used for crop production, 736 ha for grazing, 14308 ha forest and bush land, 3800ha water body and 1000 ha is wasteland. The average land holding per household is estimated as 0.5ha. Altitude of the Woreda ranges from 1488-2900 m.a.s.l.

The Woreda has two rainy seasons, one is the short rainy season known as “Belg” from February to end of May and the main rainy season or long rainy season known as “Meher” from July to end of December. Using this Agro-ecology and soil situation farmers are growing a variety of crops. Such as teff, sorghum, wheat, maize barely beans etc. It is during this Belg season that unreliable rainfall creates situations of food insecurity. Livestock production continues to be the major economic activity and is still the status symbol for farmers in Tehuledere Woreda.



Source. Ethio-GIS Database-2000.

3.2. Data type

Primarily the study used both qualitative and quantitative approaches for data gathering and analysis. Based on the research objective and questions, the study was designed to be qualitative and descriptive research, which focuses on the assessment of the implication of sustainable land management to ensure food security in Tehuledere Woreda, South Wollo zone.

3.3. Data source

In this research both primary and secondary data sources were used. The rural local community, the agriculture and rural development office of the Woreda, kebeles and Woreda administrators were the primary source and their reflection, opinion considered as primary data.

3.4. Data gathering instruments

The researcher used interview schedule (a combination of open-ended and close-ended), interview and focus group discussion to collect the primary data. The sources of the secondary data include all important professional published and unpublished literature, which include books, research, journals, articles, discussion papers, reports and other electronic sources.

3.4.1. Interview schedule

As already stated above, an interview schedule which includes close and open ended questions will be applied to gather the required information in the study area. Due to the geographical distribution of the population and difficultness to manage in one place the subjects, the researcher used available sampling method to select subjects of the study. The researcher selected the subjects by appointing an enumerator for gathering appropriate data by presenting in public meetings and directly going to their original residence of house hold heads.

3.4.2. Interview

In-depth interviews were held in the selected study kebeles. The participants were the representatives from different age groups, from various villages of the communities, from different economic strata and from both sexes to maintain gender balance. The participants had a chance to express their own feelings (perceptions), and shared their experiences regarding the issues of the status and productivity of the surrounding land and their subsequent food security status, challenges to sustainable land management, causes of food insecurity which have close relationships with sustainable land management and prospects of sustainable land management in the study districts.

3.4.3. Focus group discussion

A separate 15-20 minutes of focus group discussion was held among the DAs and Land Administrators of the respective kebeles on the one hand and the officials of the Agriculture and Rural Development office of the Woreda. From each of the sample kebeles one DA and one land Administrator, generally two individuals and six Kebele representatives were selected for the intended focus group discussion.

3.5 Respondents and Sampling Techniques

The participants of this study included the local rural people of the selected kebeles, and concerned officials in the Woreda. Due to time and financial constraints, the researcher took 193 sample respondents using Yemane formula by taking the precision level (0.07). To this study the researcher selected the sample kebeles from all agro-ecological zones of the Woreda. In order to achieve this purpose, the researcher selected three kebeles from "Kolla'', "Wina-Dega" and "Dega" agro-ecological zones. Kebele (08) Amumo from "Kolla", Kebele (09) Kundi Meda from "Wina-Dega" and Kebele (07) Messal from "Dega" were selected on the basis of frequent vulnerability of the kebeles by flood and drought for the last three years in the Woreda. All the kebeles were selected purposively from different agro ecological zones; and this enabled the researcher to get the data or the opinion of subjects from all agro ecological zones of the Woreda. The researcher has kindly requested the respective kebeles' administrators to get the total number of household leaders (family leaders) of each kebeles. The sample size of each Kebele was determined by using stratified sampling method in the following way.

3.6. Sample size

There are several methods for determining a sample size. For this purpose the researcher applied a simple formula from Yamane (Yemane 1967) to determine the sample size. This formula could be used to determine the minimal sample size for a given population size.

$n=N/1+N(e)^2$ ………………………………………….. (Yamane Taro, 1967)

Where

N=Total population of all sample kebeles

e=Level of precision

n = sample size

Source: Yamane, Taro. 1967

Thus, $n=4057/1+4057(0.07)^2=193$

Therefore, sample size=193

Table 3.1

Sample size of the respective kebeles.

No	Kebele	No of House Hold Leader (N)	Sample Size (N)
1	Amumo (08)	1224	58
2	Kundi Meda (09)	1531	73
3	Messal (07)	1302	62
	Total	4,057	193

Source: Tehuledere Woreda Kebele Administrations of respective kebeles.

3.7. Method of data analysis

Information generated through in depth interview and focus group discussions was qualitatively analyzed using a direct reflective interpretation of the views and discussion results presented. While the information gathered through questionnaire was analyzed using Descriptive Statistical Analysis. Descriptive statistics such as frequencies and percentages were applied. For the sake of making the task of interpretation easy, a computer software program known as SPSS version 14 was used.

4. Data presentation and analysis

4.1. Respondents and characteristics

The data have been presented sequentially according to the respective objectives outlined in chapter one of this paper. The analysis part is made on the basis of the data presented in the tables and charts. Thus, the presentation part is followed by the descriptive analysis of the data presented.

To begin with, the researcher would like to briefly highlight the demographic characteristics of the sample populations.

4.1.1. Demographic characteristics

In most cases, it is common to see that the overwhelming part of sample populations are male dominated. Various studies indicate that these male headed households are capable enough to conserve their soil properly as they have the potential to adopt and utilize SLM technologies (Hurni, 1988).

The study shows that out of the total of 193sample populations, 184 (95.3%) are male household heads, while the remaining 9 (4.7%) are female headed households. Thus, the population is almost totally male headed ones which is an opportunity to scale up SLM technologies in the study area.

4.1.2. Educational status of the household

Most of the studies conducted in rural areas indicate that the educational status of the people in most study areas is so low. However, the same studies indicate that such very low educational status is a factor behind the limited adoption and utilization of SLM technologies (Hurni, 1988).

Out of 193 household heads, who were covered by the survey, 106 household heads (55%) were illiterates (have never been to school), 52 household heads (27%) can read and write, 28 household heads (14.5%) attended elementary school and the remaining 7 household heads (3.6%) educational levels are above elementary school. The study is consistent with the CSA data. Education levels are very low; the rate of adult literacy in the rural Ethiopia highlands (including Tigray, Amhara, and Oromya, the main highland regions) was only 15 percent in 1994 (CSA 1995).

Education is an important determinant of household food security in that, educated households have a better chance of adopting soil conservation measures (Million and Belay, 2004) which in turn increases crop production. Moreover, educated households are very sensitive to management of renewable and non-renewable resources in view of averting risk condition of food insecurity.

Much of the literature insisted that educated farmers have a strong tendency to increase households' access to credit as well as their cash income, thus helping to finance purchases of physical capital and purchased inputs. This may help to promote production of high value crops, as well as promoting greater use of such capital and inputs in producing traditional food crops. Education may promote adoption of new sustainable land management technologies by increasing households' access to information and their ability to adapt to new opportunities (Feder, et al. 1985).

4.1.3. Age status of the households

Out of the total of 193 sample populations, 97 (50.3%) reported that their age is between 40 and 50.Other significant proportions71 (36.8%) responded to the same question that their age is found between 30 and 40.Only one respondent is found to have the maximum age limit between 60 and 70.There are also 7 individuals (3.6%) whose age limit is found between 18 and 30.Generally, the figure indicates that the people of the study area is an adult group which is active enough for deployment in agricultural activities.

4.1.4. Household family size

The maximum family size for the sample population is 9-10 family members 96(49.7%) and the minimum are 1-3 family member 9(4.7%).There is also a large family size comprising 4-8 family members 82 (42.5%).This figure indicates that population is growing at an alarming rate in the study area, having its own impact on food security. A study by (Yilma et al. 2010) stated as a large family size results in increase of food demand ultimately ends up with food insecurity. (Hurni, 1993) shows that loss of land resource productivity is an important problem in Ethiopia and that with continued population growth the problem is likely to be more important in the future.

In the literature, the effect of population pressure on natural resource conservation has taken two divergent views. The idea of the Malthusian hypothesis (Gillies et al, 1996) is that the increase in population in a geometric fashion followed by the increase in the demand for natural resource. However, the supply of these natural resources is increase only linearly. Thus, in the Malthusian thesis population is regarded as a threat to natural resources (Gillies et al, 1996).

In contrast to this view, the BOSERUP thesis advocates population pressure is a significant factor for the intensification of agriculture and hence for the adoption of improved farming practices (Boserup, 1965). This view is clearly anti-Malthusian. Increase in the number of population results in increase in the value of land. This induces even the poor peasants to invest in soil erosion controlling measures (Boserup, 1965). Hence, increase in population through its effect in increase in demand for food and for land will eventually lead to conservation investments to occur (Tiffen et al., 1994). The anti-Malthusian idea indicates how private property rights develop over the long run in response to population growth.

Echoing the dire predictions of Malthus, many observers see population pressure as the fundamental cause of land degradation in Ethiopia and other developing countries (WCED 1987; Grepperud 1996). However, others have argued, following Boserup, that population pressure induces households to intensify agricultural production, invest in land improvements and develop land - saving innovations, eventually resulting in improved resource conditions and possibly improved welfare (Tiffen et. al.1994).

4.2. Farm land characteristics

4.2.1. Land size

Household land size is one of the factors that affect SLM and food security significantly. Generally, the land size of the sample populations indicate that the land size is very small as can be seen from the chart 1 below.

Out of the total of 193 respondents, the significant majority reported that their land holding size is3-5 tsimad, while another great majority 76(39.3%) reported that they have a farm land size of 6-8 tsimad. Only 13(6.7) individuals have land size of above 9 tsimad. Generally, the study area is characterized by very small farm land size. This figure is consistent with a study conducted by (Ogbasellasie 1995) Agriculture in the Ethiopian highlands is dominated by very small scale mixed crop-livestock subsistence farms, usually operating less than 1 hectare. Due to population pressure and several land redistributions conducted since the fall of Emperor Haile Selassie in 1974, farms larger than a few hectares are rare, except for state farms established by the Derg regime (ibid).

In traditional agriculture, land and labor are the significant production inputs to the peasant farmer. In this study it has also been confirmed that land ownership was a significant factor to food security. Not only access to land, but also the size of land holding was also found to be significantly important factor in food production and food security. Land size is considered a critical production factor that determines the type of crops grown and the volume of crop harvested. Literature indicated that about 80% of the increase of agricultural output in Africa has been attained through the expansion of cultivated land (Degefa, 2002).

A study conducted by Alene (2008) and others indicated that Land is the main stay of subsistence farmers in developing countries; hence, access to land and the size of the parcel will have a significant role in farm production of the household. Other empirical studies have argued in support of the significance of land holding in grain production. David, L. et al (1994) indicated that land holding was found to be a determinant factor of calorie production and over all calorie availability in the household in rural Mozambique. Relatively land rich households nearly all reached 80% of their calorie requirement; this could be due to strong dependence of calorie availability in subsistence farmers to land holding. This might have resulted that a household with larger land holding to be found in better position of calorie production than those of land poor households (David, L. and Michael, T.W.

1994).In support of this argument, Alene 2008, argues that the size of cultivated land had positive and significant influence on household food production.

4.2.2. Slop of the farm land

As a matter of chance, a very much small proportion of the farm land of the selected sample farmers, only 34(18%) have plain farm lands, the rest being hilly82 (42%) and steep 78(40%) from the total samples. These types of topography i.e. steep and hilly are highly exposed to soil erosion. The physical land forms and features (e.g. steep slopes) are one of the main factors that aggravate erosion by causing runoff, spatial separation of farms, and irregular shapes of land plots and scattered settlements. A study conducted by Pender, Place and Ehui (1999) is consistent with such a figure. It revealed that dominated by Nitisols , which are derived from volcanic rocks, the northern parts of Ethiopia are characterized by moderate to steep sloping land and thus there is a need for soil conservation measures to ensure continued productivity of soils.

Other studies indicate that terraces are the preferred type of soil conservation in such topographies as hilly and steep. This is due to the potential benefits the structures provide to such sloppy areas. They convert marginal land (hillsides) into cultivable, arable land; reduce land scarcity, provide protection from erosion, good conservation of soil and applied fertilizers efficiently, conserve both soil and water and increase soil fertility and crop yield in particular near the lower end of the terrace (siltation of eroded topsoil) (Mitiku et.al 2006).

4.2.3. Fertility status of the farm land

Generally, out of the total of 193 sample households, 115(59.6%) reported that their farm land fertility status is poor, while 37(19.1%), less fertile, 24(12.4%) medium fertile and 17(8.9%) have fertile farm lands respectively. The main factor contributed to the poor fertility status of the farm land is soil erosion. The gross discounted cumulative cost of erosion in Ethiopia has been estimated to be as high as $1.25 billion (Kappel 1996).

Available literature shows that such dangerous fertility status can be halted by using indigenous technologies with potential to substantially increase crop productivity, including stone terraces, reduced tillage and reduced burning. Since stone terraces help to conserve soil moisture, they also increase the benefit of using fertilizer. Studies conducted by Gebremedhin et al. (1998) in southern Tigray, neighboring area to the study area, found that investment in stone terraces is fairly profitable in northern Ethiopia. It also confirmed that sustainable agriculture practices such as reduced tillage and reduced burning can also boost productivity by conserving soil organic matter and soil moisture (Shaxson, 1988; Reijntjeset al., 1992.

As indicated in the table above, the largest proportion 164(85%) of the sample farmers reported that the fertility status of their farm land is decreasing. The most important factor found being land degradation and the subsequent soil erosion , the existing literatures signifies this fact in that the average annual soil loss from arable land in the highlands of Ethiopia was estimated to be about 42 tons per ha per year and the average annual productivity decline in cropland was 0.21% (Hurni, 1993). Furthermore ,the value of the total agricultural production loss due to soil erosion in the 1990s was estimated to be 32.2 million Ethiopian Birr, which according to Sutcliffe (1993) constitute 1.1% of the 1990 agricultural GDP.

Several studies indicate that land degradation mainly caused by soil erosion has been one of the chronic problems in Ethiopia (Berry, 2003; Nyssen et al., 2003a; Dregne, 1990; Hurni, 1988a). Although Ethiopia’s biophysical potential is significant, land degradation and poverty continue to challenge sustainable agricultural development opportunities. (Studies on land degradation in Ethiopia include Kassie et al. (2008); Olarinde et al. (2011); Shiferaw and Holden (2001); Tefera et al. (2002); Zeleke and Hurni (2001); Okumu et al. (2002); and Sonneveld (2002).) This problem is further aggravated by high population pressure in rural areas – currently 86 percent of Ethiopia’s 80 million inhabitants live in rural areas, climatic variability, limited use of sustainable land management practices, and a high dependence on rain-fed agriculture. Moreover, deforestation due to farmland expansion and energy needs, as well as fragile soils, undulating terrain, and heavy seasonal rains make the highlands of Ethiopia highly vulnerable to soil erosion and gully formation.

4.2.4. Degree of erosion

The study revealed that most of the farmers 131(67.9%) have experienced with sever risk of soil erosion; followed by small respondents 43(22.3%) claiming moderate risk of soil erosion. The rest 19 (9.8%) respondents reported that there is minor risk of soil erosion in the study area. Studies conducted by (Pender et.al 2005) confirmed this study indicating that Soil erosion in Ethiopia averages nearly 10 times the rate of soil regeneration, and the country has among the highest estimated rates of soil nutrient depletion in Sub-Saharan Africa. The same study indicated that such land degradation reduces average agricultural productivity and increases farmers' vulnerability to drought by reducing soil depth and moisture-holding capacity (Ibid). The combined effects of low productivity and ecosystem degradation lock the poor in a vicious cycle of food insecurity at the minimum and poverty and environmental degradation at the final consequence.

There are several studies that deal with land degradation at the national level in Ethiopia. These include the Highlands Reclamation Study (EHRS, FAO, 1986), the National Conservation Strategy (Sutcliffe, 1993), the Ethiopian Forestry Action Plan (EFAP, 1995) and studies on the effect of soil degradation on agricultural productivity (Keyser and Sonneveld, 2001) and on the environment (Nyssen et al., 2004a). Conclusions from these studies vary in detail. The EHRS concluded that water erosion (sheet and rill erosion) was the most important process and that in the mid 1980's 27 million ha or almost 50% of the highland area was significantly eroded, 14 million ha seriously eroded and over 2 million ha beyond reclamation. Erosion rates were estimated at 130 tons per ha and year for cropland, and 35 tons per ha and year on average for the entire highlands. But even at that time estimates were regarded as high. In the highlands of Ethiopia, the area of greatest livestock density and the area of major land degradation, recorded

measurements of soil loss by water erosion range from 3.4 to 84.5 tons per ha per year with a mean of 42 tons per ha per year (Nyssen et. al. 2003; Shibru, 2003; Hurni, 1993; Hurni, 1987b). This represents a loss of 4mm of soil a year, which is twenty or more times replacement rates (Hurni, 1993). Keeping in mind that losses are unevenly distributed, many locations are even more seriously affected. Local benefits of re-deposition of eroded material may be rare, since many re-depositions are far away. In addition, the effect of physical soil loss is accompanied by nutrient loss, especially nitrogen and phosphorus, and estimates of these losses from, are considerable (Bojo and Cassells, 1995; Sutcliffe, 1993). As estimates of the severity of land degradation in Ethiopia vary so do cost estimates (Bojo, 1996).

4.2.5. Distance between home and farm land

The study revealed that out of the total of 193 respondents, 86(44.6%) agreed that they have a distance constraint for easily applying sustainable land management technologies on their farm. Farmers are more likely to use fertilizer, improved seeds, and manure/compost on plots closer to their residence, probably because of the difficulty of transporting inputs to distant plots. This is consistent with the findings of Gebremedhin and Swinton (2003) who reported that farmers in central Tigray were more likely to use stone terraces on plots nearer to the homestead in the sense that more intensive land management is used on plots closer to the residence.

4.3. Sustainable land management technologies in the study area

4.3.1. Soil/stone bund terraces

The study indicated that most of the people 145(75.1%) in the study area do not apply stone bunds, while only 48(24.9%) use in their farm land. This is due to lack of awareness among the farm households, very much insignificant role of DAs and low level participation of NGOs and other development partners in the study area.(See table 8 below)

4.3.3. Improved seed

As indicated in table 10 above, with very few exceptions, the significant majority of the respondents 174(90.1%) replied that they do not use improved seed. Only 19(9.9%) use improved seed in the study area. When asked why they do not use, their responses were related to financial constraint, as the cost of the improved seed is not affordable in the economic development level of the local farm households.

The interview result also holds the same cause for the limited application of the improved seed by most of the farmers in the study area. One of the interviewee stated that;

"Since their introduction in the past 15 years in to the agriculture sector in our Kebele, I never use improved seed. I want to use them if I get, because I have seen an individual who used improved seed and has been productive more than ever before. Unfortunately, I can't afford to buy the seed due to the high cost of the seed when comparing with the unimproved ones. (Y,A 2014)"

4.3.3. Irrigation

In the study area, the use of irrigation is insignificant. 167(86.5%) of sample farm households do not use irrigation while only 26(13.5%) use irrigation on their farm land. The major reason behind such a limited usage of irrigation in the study area is topography, i.e. the mountainous and steep hills nature of the farm lands which is not appropriate for irrigation. As observed in the study area, irrigation is halted by topography of the land. Water is available only through the valleys and much of the mountainous farm is out of irrigation.

The FGD also confirms such a mountainous and terrain nature of the land and it's inappropriateness to irrigation. It alternatively proposed that it is possible to use other productivity enhancing technologies to conserve the farm soil and improve farm productivity in such topographies. In addition to this, instead of irrigation, the focus group discussants proposed and applied rain water harvesting technology.

4.3.4. Manure

Among the total households sampled, a very small proportion of the respondents 57 (29.5%) reported that they use traditional manure as a means to maintain the soil fertility of their land, while 136(70.5%) do not use traditional manure in the study area. While asked as to why they do not use manure in their farm land, they mentioned different reasons. Distance of the farm land from their home and lack of livestock are the major ones that hindered usage of manure by farmers in the study area. (See table 12 above)

4.3.5. Check dams

Unlike other SLM technologies, a huge number of farmers120 (62.1%) use check dams to conserve their soil on their farm land. This is a promising opportunity for the study area to apply SLM technologies. The rest 37.8% do not use check dams on their farm. When asked as to why they do not apply check dams on their farm land, they replied that this is related to the nature and slop of the land. Alternatively, they stated that they use terracing and other technologies.

4.3.6. Planting trees

Though planting trees is not a new a new kind of investment on land, the application of the technology in the context of soil and water conservation is so low and evolutionary. In this regard, a substantial number of the respondents 114(59%) replied that they do not plant trees around farm land areas with the aim of protecting the land from degradation while 79(41%) plant trees on their farm.

Interview with a local farmer indicate that mostly the farmers plant trees for house construction, fuel, sell and other purpose. As one of the interviewee explained that;

"So far, I have planted several tree species mainly eucalyptus tree, but I did not do that with the objective of protecting degradation of my land. But trees give a number of benefits to farmers. In time of food shortage, I sell my tree and buy a food for my family. Besides this, I used them for house construction and fuel consumption."(J.N 2014)

This indicates that farmers are not aware enough about the role of planting trees to protect soil erosion in gradient slop farm lands. Therefore, awareness creation campaigns should be arranged through DA's and other concerned bodies.

4.3.8. All SLM technologies users

There is a small potential and trend of using all the above mentioned SLM technologies in the study area. About 9.3% of the farmers reported as they are using terracing, commercial fertilizer, Check dams, traditional manure, improved seed and others on their farm land. But the vast majority replied as they never use all of these technologies except a single of technologies.

4.4. Constraints for the successful scaling up of SLM technologies

4.4.1. Lack of awareness of SLM technologies

The greater number of the farmers 111(57.5%) replied that they have the awareness about SLM technologies, while 82(42.5%) report as they have a problem of lack of awareness. In addition to the financial constraints, lack of awareness is found to be another constraint for adopting and applying SLM Technologies in the study area.

The most important source of information to the rural farmers is radio. No any other effective mass media or any other source of information is available as it is seen in the following interview result.

“We farmers have our own indigenous soil and water conservation system developed for centuries. We didn’t get any other additional training other than this. Awareness creation campaigns are not accompanied by trainings for us. What is the opportunity is since the soil is being washed away mostly by flood; we will prepare our land in the seasons out of growing and harvesting. It became our own responsibility to conserve our soil and we do not expect anything from the DAs or anybody else who have a stake in the issue. (G.G, 2014)”

This interview result is consistent with A study conducted by Wogayehu (2003) indicate that peasants have been aware of problems related to soil erosion and developed different indigenous soil and water conservation practices that sustained agriculture for centuries.

Though, access to information is very much indispensible for the farmers to get lessons with regard the effectiveness of sustainable land management in terms of creating fertile ground for soil conservation and production. Earlier studies in this regard also show that farmers with better access to agricultural experts invest more in land management in Ethiopia (Bekele & Drake, 2003; Kassie et al., 2008). Therefore, access to information either through DAs or the media, is limited and it is one of the factors played significant role in affecting farmers investment in SLM.

Information about soil and water conservation technologies

What is clearly observed is the negligible role of the government to facilitate the soil and water conservation practices through DAs, giving necessary trainings and information in this regard. Accordingly, only 8(4.15) of the sample farm households respond that they get information on soil conservation technologies from DA’s. However, a study conducted by Pender and Gebremedhin investigated that contact with the agricultural extension program also has insignificant impact on crop production. The largest proportion 133(69%) reported that they get such a knowledge of soil and water conservation practices from the tradition, learnt by self; followed by 22(11.3%) from the nearby neighbors, 19 (9.9%) from the media, and 11(4.1%) from NGOs respectively. As most of the farmers have no the access to media, except a small portion of the farmers listening radio, they are unable to get information concerning sustainable land management technologies from the media easily.

4.4.2. Negative attitude

Almost all of the farmers 185 (95.9%) agreed that they have no any problem with regard to SLM technologies. Only 8(4.1%) of the total sample households have a negative attitude towards SLM technologies. This indicates that the people are eager and open to adopt SLM technologies in the study area. On the other hand, presence of resistance to change is not a problem in the study area and this is an opportunity for future scaling up of SLM technologies.

4.4.3. Lack of interest

Lack of interest among the farmers to scaling up of SLM technologies in the study area is not a problem. In support of this, 184 (95.3%) sample farmers agreed that they have no a problem of lack of interest in promoting SLM technologies. Only 4.7% have lack of interest to implement SLM practices. Their response when asked as to why they lack interest to implement SLM in the face of soil erosion and productivity decline was related to lack of awareness.

4.4.4. Lack of considerable trust on slm practices

As it can be seen clearly from the respondents’ response above, there is a great problem on the part of the farmers in that, they do not have a considerable trust on SLM technologies. Though they usually use swc practices to conserve their soil, they do not completely relied up on the technologies as a viable means of land management. Generally, 154(79.8%) of the respondents have agreed on this issue.

4.4.5. Lack of resources endowment

Also an equally important factor that affects farm land management is lack of resource endowment of the farm households in the study area. However, large land holdings are often related to more livestock, which enhances the availability of animal manure (Shiferaw & Holden, 1998), and it is a source of cash, increasing the availability of farmers' financial capital to invest in land management. Other studies indicated that farmers with more livestock invested more in land management in Ethiopia (Pender & Gebremedhin, 2007). Therefore, it is possible to conclude that the available very much limited resource endowment is one of the factors that hinder farmers not to invest in SLM in the study area.

4.4.6. Financial constraints

The study revealed that financial constraint is not a significant constraint that affects the successful scaling up of sustainable technologies in the study area. The majority 108(56%) of the respondents replied that it is not a constraint while 85(44%) agreed as it is a constraint. However, the FGD result indicates that finance is an important factor influencing the application of SLM technologies. For example, finance is a constraint behind insignificant application of improved seed, pesticides and insecticides in the study area.

4.4.7. Lack of access to information

Concerning access to information, only 34(17.6%) respondents have reported that they have access to information i.e. media, (most commonly used is radio).The rest of the respondents 159(82.3%) reported that they have no access to information. However, access to information is very much indispensible for the farmers to get lessons with regard the effectiveness of sustainable land management in terms of creating fertile ground for soil conservation and production. Earlier studies in this regard also show that farmers with better access to agricultural experts invest more in land management in Ethiopia (Bekele & Drake, 2003; Kassie et al., 2008). Therefore, access to information either through Das or the media, is limited and it is one of the factors played significant role in affecting farmers investment in SLM.

4.4.8. Lack of social capital

The study revealed that only 81(42%) of the sample households have access to social capital. Studies indicate that Social capital affects land management positively. Households with members of a village council use more labour per hectare and are more likely to use improved seeds and intercropping. Such households appear to be more oriented towards intensive crop production than other households (Pender and et.al 2001).The positive influences of social capital are twofold. First, social capital can promote cooperative behavior and facilitate flows of information that may be relevant to land management investments (Adesina, Mbila, Nkamleu, & Endamana, 2000; Bowles & Gintis, 2002). Second, in the absence of formal credit markets, social capital enhances informal credit exchange among farmers (Knack & Keefer, 1997) and improves farmers' financial capacity to buy fertilizers.

4.4.9. Land tenure system

One of the key issues related to the constraints to sustainable land management is land tenure system. I.e. the degree to which the tenure arrangement encourages improved land management. The assessment of better land management is evaluated in relation to farm practices such as crop rotation, terracing, fallowing and tree planting and other soil conservation practices.

The existing land tenure system in the country does not have any impact on the land investment of the farmers. In the context of Ethiopia, according to Article 40 sub-section 3 of The 1995 Ethiopian constitution, land is entirely under state ownership. Out of the total respondents, almost all, 191(98.9%) have agreed that it does not affect their investment on their and.

Various researches carried out in different countries have demonstrated that there is no relationship between land tenure security and investment on land. Goeschl and Igliori (2006) indicate that property rights' arrangements can not generally guarantee efficient management of natural resources. Likewise, the World Bank study in Ghana and Rwanda found that an increase in individualized land rights (private ownership) does not appear to have had any effect on soil conservation practices or land investment (Plateau, 1996).

4.5. Farmers' perception on the role of SLM to ensure food security in the study area

4.5.1. Improve soil fertility

The study indicated that SLM technologies have immense role for improving soil fertility. A very significant number 107(55.5%) of farmers replied that SLM technologies have a significant role to improve soil fertility.

In the face of very serious soil erosion, the need to scaling up of SLM technologies is so high. This is because, even nationally, the country has critical erosion problem and eroded soil profile. Ethiopia has been described as one of the most serious soil erosion areas in the world (Blaikie, 1985; Blaikie & Brookfield, 1987) with an estimated annual soil loss of about 42 t/ha/yr from croplands, resulting in an annual crop production loss of 1 to 2% (Hurni, 1993). Repeated problems of famine and starvation, currently well-known images of the country, have been attributed at least partly to this phenomenon of soil erosion (Eckholm, 1976; Blaikie, 1985; Hurni, 1989, 1993).

In many parts of the country, recurring starvation and famine are still parts of rural life. According to the 1985 Ethiopian Land Reclamation it is estimated that only 20% of the total area of the Ethiopian highlands have relatively minor problems of erosion; 76% are significantly or seriously eroded and 4% have outstripped their capacity to be of any value for production.

Therefore, without SLM technologies, what any other mechanism can be a solution for such acute soil erosion taking place in the country in general and in the study area in particular?

4.5.2. The role of SLM to protect land degradation and soil erosion

SLM technologies play a critical role in protecting soil erosion and land degradation. The perception of farmers in the study area indicated that it has the role of SLM technologies is so high in terms of protecting soil erosion. That is why most of the sample respondents 116(60.1%) reported that it has immense role to protect land degradation and soil erosion.

Soil and land degradation is one of the fundamental problems confronting sub-Saharan Africa in its efforts to increase agricultural production, reduce poverty and alleviate food insecurity (Hailu et al.1993). Unfortunately, many conservation programs designed to address soil and water degradation in the traditional agricultural sector have fallen far short of expectations. Several studies have showed that despite a number of potential soil and water management technologies developed, adoption by farmers is still very low. This has been due to a complex socio-economic and demographic factors that have affected the choice of land and water technology investment to improve food security. Gaps have been identified in the way researchers and extension workers have packaged research result to make them more user-friendly for the farmers. Knowledge sharing mechanisms have not been incorporated in the broader agricultural extension systems to help disseminate success stories emanating from research.

As studies conducted by Pender et.al (2006) revealed, the government of Ethiopia and a consortium of donors have undertaken a massive program of natural resource conservation to reduce environmental degradation, poverty and increase agricultural productivity and food security. However, the adoption and adaptation rate of sustainable land management (SLM) practices is low. In some cases, giving up or reducing use of technologies has been reported (Kassa, 2003; Tadesse and Kassa, 2004). Several factors may explain the low technology adoption rate in the face of significant efforts to promote SLM practices. These include a poor extension service system, blanket promotion of technology to very diverse environments, top–down approach to technology promotion, late delivery of inputs, low return on investments, escalation of fertilizer prices, lack of access to seasonal credit and production and consumption risks (Kassa, 2003; Bonger et al., 2004; Dercon and Christiansen, 2007; Kebede and Yamoah, 2009; Spielman et al., 2010).

4.5.3. Maintains ecological balance

Of the total respondents 121(63.7%) agreed that SLM technologies have the potential to maintain the balance of which is already degraded ecology in the study area (see table 29 above). The increasing growth of human population, the consequent need to cut trees for construction and other needs, the forest is being lost from time to time. Therefore, successful scaling up of SLM technologies in the study area will promote afforestation programs which can maintain the degraded ecology (Hurni, 1988). Drought, desertification, lack of rainfall, and deforestation are problems directly related to one another and can only be mitigated if significant SLM technologies are applied.

4.5.4. Boost agricultural production

Much of the respondents 134(69.5%) reported that scaling up of SLM technologies will boost agricultural production which result in improvement in food security status of the people. For people living in the study area, whose life is dependent up on subsistence farming system, what should be the task for improving life, other than protecting and conserving the land in a sustainable manner?

Literature found from Economic theory indicates that productivity change can be decomposed in to two sources: change in technology and change in efficiency (Coelli et al. 1998). In this terminology, "technological change" means pushing the production possibility frontier (PPF) outward, and "improving efficiency" means producing as close as possible to the available PPF. A vital relationship between the two is that a change in technology can also bring a change in efficiency. Most importantly, the effect of technological change on efficiency can be positive or negative. Hence, it can be said that the effect of a SWC technology, as observed in yield change, is the net effect of the two sources: the direct technology effect and the indirect efficiency effect.

4.5.5. Improve food security

In the study area, SLM technologies play an important role in improving food security 110(57%) of the respondents response indicated that SLM technologies have immense role to improve food security in the study area. However, about 83(43%) replied it does not have such an important role. When asked, the response of these groups was related to their participation in off farm income generation activities.

However, the argument of much of the literature revolves around the first ones. Agriculture is the dominant economic sector in Ethiopia that accounts for about 45% of the GDP, 85% of the employment and 90% of the foreign exchange earnings. The vast majorities of the population, about 85%, lives in rural areas and derive their livelihoods directly or indirectly from agriculture. The agricultural sector is predominantly subsistence in nature, in which the major part of farm production is for household consumption. Small-scale subsistence farms, with an average land holding of less than one hectare, occupy about 90% of the cropped land and produce around 95% of the total agricultural output (Gronvall, 1995).

4.6. Major causes of food insecurity in the context of SLM

4.6.1. Land degradation and soil erosion

As a major problem for the decline of agricultural production, land degradation and soil erosion are placed at the center of the causes. Sample farmers with substantial number 147(76.2%) reported as land degradation and soil erosion are causes of food security in the study area.

Literature also indicated that the increase in human population brought with it increased deforestation, overgrazing, shortening of fallow periods between cropping, expansion of cultivated land into marginal and steeply sloping terrains, and inevitably resulted in accelerated erosion. As a result, soil erosion has become of serious environmental concern in the sub-humid regions of Africa, including Kenya, Ethiopia, Tanzania, Nigeria and other countries lying along the south side of the Sahara (Grove, 1974). As indicated earlier, much of soil erosion takes place from cultivated lands and its effects are reflected in the agricultural sector. This sever erosion resulted in decline of agricultural land productivity which in turn result in food shortage and food insecurity in the study area.

The big question to be raised here is what aggravates of the soil erosion and land degradation.(See table 33 below)

Factors aggravating soil erosion

As it can be seen from the table below, the perception of farmers about factors aggravating soil erosion, the overwhelming majority 148(76.7%) responded that all factors mentioned in the table, such as slope of the land or topography, rainfall (in the form of flood), the erodibility nature of the soil and run off from up slop areas are all factors that aggravate soil erosion in the study areas

As already discussed above, all the factors mentioned i.e., slop of the land (topography characterized by mountainous and steep, hilly), the nature being too easy and too erodible easily by water and wind and the highly seasonal and unreliable rainfall experienced in the area are the features of the study area. According to de Graaff 1993), determinants or direct factors of influence of erosion are rainfall (erosivity), vegetation (ground cover), topography (surface forms, slope inclination and exposure to sun), and soil properties (erodibility).

In the study area, Agricultural production takes place in two cropping seasons per year, the Meher and Belg seasons. Recently, the Belg season rains have failed in several consecutive years, although this was rare in the past (Pender, Shiferaw and Holden 2005).

The FGD results also holds that several factors are responsible for aggravating soil erosion in the study areas. These includes among others, the sloppy and terrain nature of the land, seasonal and very much variable rainfall which result in huge flood, Overgrazing, deforestation, frequent plough due to small size of land as a result of density of population, population growth and others.

4.6.2. Lack of adequate rainfall

Apart from the interview schedule result, it was evident from the observation survey that there is a lack of adequate rainfall in the study area. Average rainfall range registered for the past 7 months of this year is 600mm. Lack of rainfall has experienced for a long time so far. The FGD result also clearly indicated this fact. According to the information obtained from the kombolcha Metrological agency, annual rainfall is well between 600 and 700mm. As shown from the table above, the substantial majority 169(85.5%) reported that lack of rainfall is the cause behind food insecurity in the study area. Literature also indicated that the limited, if not absent of the scaling up of SLM technologies in a given area, especially in East Africa, will inevitably result in deforestation, and degradation which in turn result in lack of rainfall (Hurni, 1988). In this regard, FGD held among the officials of Agriculture and Rural Development, confirmed that forests are on the verge of extinction due to the huge demand for construction purposes and as a means of copping strategy for food shortage. It further revealed there is a significant shortage of rainfall and this affected the productivity of the farmers for a long period of time. Indicating the prevalence of the problem, the FGD result suggests a temporary and if properly applied sustainable means of response to very much rainfall experienced in the area. The rain is very poorly distributed in both spatial and temporal terms. Often there is too much water during a few days of the year, while water supply is insufficient during most of the year. As the problem persists for so long, we start to adopt a SWC technology known as rain water harvesting. The assumption was that, if one conserves the excess water during heavy rains in the rainy season so that plants can use it in the latter times during dry-season and it may be possible to avert the majority of the production loss due to moisture stress.

Therefore, rainwater harvesting is increasingly becoming acceptable for responding to food insecurity in the study districts. Accordingly, Rain water harvesting is currently a high priority of the Ethiopian government and this program is well on its way.

Therefore, they are mainly concerned with enhancing the productivity of the rainfall (i.e., more crops per drop) by making more available to the plants and less to surface runoff. The benefits are three fold: Less erosion because runoff is reduced; greater food Security by increased crop water availability and as a by- product increased ground water recharge leading to Higher base flows and more precision irrigation during the dry season.

Concerning the direct impact of lack of rainfall on agricultural production, a study carried out by (Rockstromet al., 2002) indicated that lack of rainfall and its seasonal variation in rain fed agriculture, which occur frequently, are responsible for a decrease in yield by about 70% or even sometimes a total crop failure.

Several studies confirmed such a fact in that erratic rainfall patterns present serious challenges to food production in these areas (Fisher et al. 2004), and this will be further worsened by climate change which is expected to increase rainfall variability in many African countries that are already at least partly semi-arid and arid.

Therefore, it is possible to conclude that successful scaling up of SLM technologies is the solution for the variable rainfall experienced in the study area.

4.6.3. Low level scaling up of SLM technologies

Even though, there is a considerable lack of awareness among the farmers with regard to the role of SLM in the study area, the sample households do not conceal to indicate that the very limited application of SLM technologies is at the core of the causes of the existing food insecurity prevailed in Tehuledere Woreda. Accordingly, 99(51.2%) witnessed this fact. This is because, they know that the only tangible resource and viable basis of their life is based on land.94(48.8%) disagree on the issue and this might be due to the lack of awareness about SLM technologies and their role to improve their food security status at large.

Various studies indicate that the absence of considerable SLM technologies adoption and application have a far reaching consequence in the long run. These concerns are substantial in Ethiopia where the agriculture sector the most important sector for poverty reduction has been undermined by lack of adequate plant-nutrient supply, depletion of soil organic matter, and soil erosion (Grepperud 1996). In an effort to overcome these challenges, the government and non-governmental organizations have consistently promoted chemical fertilizer as a yield-augmenting technology. Despite this promotion, chemical fertilizer adoption rates remain very low (Byerlee et al. 2007), and in some cases, there is evidence suggesting a retreat from fertilizer adoption (EEA/EEPRI 2006), possibly due to escalating fertilizer prices and production and consumption risks (Kassie, Yusuf, and Köhlin 2008; Dercon and Christiansen 2007). More importantly, government policies to promote technologies lack a clear understanding of the role of agro-ecology, such as rainfall, in conditioning the effectiveness of technologies in enhancing productivity. The distribution and amount of rainfall varies both in spatial and temporal terms across and within Ethiopia. This implies that it is important to consider the distribution of rainfall when formulating policies that promote adoption of productivity-enhancing sustainable land management technologies, such as chemical fertilizer and conservation tillage (Ibid).

For instance, the key to tackling these challenges in semi- and arid areas lies not only in the adoption of farming technologies that enhance water retention capacities of soils in these areas but also in the adoption of farming technologies that rely mainly on renewable local or farm resources (which reduce production costs and risks). A prime example of such technology is sustainable agricultural production systems that conserve resources, such as land and water; are environmentally non-degrading; are technically appropriate; and are economically and socially acceptable (FAO 2008). In practice, sustainable agriculture uses fewer external inputs (e.g., purchased fertilizers) and more locally available natural resources (Lee 2005).

4.6.3.1. Available evidences

4.6.3.1.1. Consequences of low level scaling up of slm on the lives of the farm households

As it can be seen from the table above, the largest proportion of the respondents171 (88.6%) reported that high level of soil erosion, low level of soil fertility, climate change and low level of agricultural yield are the consequences of the absence of the scaling up of SLM practices in the study area. The high level of soil erosion accompanied by unreliable rainfall impacts the fertility of the soil negatively, which in turn impacts the productivity of the soil. Ethiopia has one of the highest rates of soil nutrient depletion in sub Saharan Africa (Stoorvogel and Smaling 1990).This leads to the food insecurity profile of the farmers in the study area. Low agricultural productivity, poverty and land degradation are critical and closely related problems in the Ethiopian highlands. Such low productivity on farms generally less than two hectares in size, contributes to extreme poverty and food insecurity, as evidenced by recurrent problems of famine and incomes of less than one dollar per person per day (Pender and et.al 2001). Other studies conducted by Pender and Gebremedhin 2007 also revealed that these problems are particularly severe in the highlands of Tigray Amhara in northern Ethiopia. Cereal yields average less than one ton per hectare in this region and over half of the area of the Tigray highlands has been characterized as severely degraded (Hurni, 1988) being the average farm size is only 1 ha., and most households subsist on incomes of less than 1$ per day.

The proximate causes of these problems are well known (Bojo and Cassells 1995; Sanchez et al. 1997) increased cultivation on steep slopes, inadequate vegetative cover on croplands, deforestation, overgrazing, burning of crop residues and dung for fuel, low use of inorganic fertilizers or integrated nutrient management, declining use of fallow, and limited adoption of soil and water conservation measures.

The result of the interview held with an individual indicated that SLM has a very vital role for food security of the study area. The individual has also linked SLM as a direct impact on the availability of rainfall as it has been experienced so far in the study area.

"The role of SLM to ensure food security to all kebeles of the Woreda is not to be underestimated. As the livelihood of the society is solely based on land, it should be conserved properly so that it will be able to yield out puts appropriate enough to deliver the food and future development of the farmers. As of now, the resilience capacity of everybody is at its minimum. Livestock development is widely affected by frequent drought. This drought is the consequence of deforestation which hinders the average rainfall experienced so far. Therefore, protection of land using indigenous soil and water conservation technologies is the only viable response to land degradation and soil erosion. (As. B 2014)"

4.6.3.1.4. Average amount of grain production in quintal

As indicated in the table below, the considerable portion of the sample farmers 76(39.3%) reported that in average, they produce 6-8 quintal per year while another significant portion 67(4-5%) reported as they produce 4-5 quintal per year in average. Only 10 (5.1%) reported that they produce above 10 quintal per a year in average. The minimum number of respondents 21(10.8%) replied that the size of their yearly average production is 1-3 quintal. This implies that the majority of the farm households are producing a yield which is too small to cover feeding the substantial number of the family members of a house hold in the study area.

In the face of frequent drought, seasonal and highly variable rainfall, land degradation and soil erosion, poor soil fertility, population pressure, low level of sustainable land management ,small land holding size and poor credit services, it is not surprising that this limited farm land provides a very small size of a crop yield.

According to the FGD result, the limited size of the agricultural yield is due to the various socio-economic and institutional and topographic related reasons experienced in the selected study districts. On top of this is the frequent drought and lack of adequate rainfall that can enable the farm house holds to adopt new technologies such as fertilizer to enhance their productivity. Therefore, the farmers are using traditional manure in place of the commercial one. In general lack of adequate rainfall is found to be the critical factor hindering the maximum possible utilization of fertilizer next to the soil type and sloppy nature of the area. We are encouraging our clients i.e. the farmers to exploit a maximum advantage from low technologies such as terracing construction, widely utilizing traditional manure, pressuring to get access to credit to halt their financial constraint to buy improved seeds.

4.6.3.1.5. Agricultural yield productivity status of the farm house holds

As it is evident in the table above, the absolute majority171 (88.6%) respondents reported that the yield obtained from their farm land is decreasing from time to time, while 12(6.2%) households reported that the yield remains the same. The rest 7(3.6%) respondents report as the agricultural yield got from their farm land is increasing. This implies that the produced yield is not enough to cover the food of the household and is family member throughout the year. This productivity decline is due to several factors in the study area (see the table 19 below).Literature indicated one of the factors is that Soil degradation contributes to rising rural poverty and food insecurity, because productivity is reduced, and Subsistence farmers are less and less able to accumulate reserves of grain (UNEP, 2002).

In consistent with this, Hurni 1993 indicated that, due to the average annual soil loss of 42 tons per ha per year from arable land in the highlands of Ethiopia, the average annual productivity decline in cropland was 0.21%.

Other studies by Alemneh and others investigated that the loss of soil nutrient and its productive capacity due to soil erosion leads to low productivity of land, which in turn brings loss in crop yields and results in a vicious cycle of poverty and food insecurity (Alemneh et al., 1997).

4.7. Prospects for SLM in the study area

4.7.1. Government effort for SWC

The participation of DAs in the study area is not significant. As seen from the table above, much huge number of the farmers 114(59%) replied that the role of the government in promoting soil and water conservation is not enough. DAs and health extension workers are not working well in a way that their work brings change on the life of the society. Land management desk officers are not doing their best with regard to land certification and other activities.

Interview result with a local farmer presents a very surprising fact which clearly shows the weak role of the government in the promotion of SLM technologies and enabling the community to improve the status of food security.

"Always a command will come from the Woreda and Kebele offices to take a fertilizer and pay the cost either immediately or in the future with a double interest rate. The funny part is that, my farm land is not suitable for commercial fertilizer. Instead, it is suitable for traditional manure to improve the fertility of the soil. As it is a command from the government, I always bring the fertilizer and inset it in river water. See this game! I don't know the reason why the government not observes the appropriateness and compatibility of the fertilizer to respective farm land before forcing us to take the risk. (G.S, 2014)"

4.7.2. Active community participation

By far, active community participation is the most important opportunity that implies a positive and promising prospect for the promotion of SLM in the study area. A development activity which do not take the community at its center, do not bear a fruit. The FGD results also indicated that the community, unlike other areas, does not request even an incentive in response to the soil and water conservation activities participated. The office of Agriculture and rural development in Tehuledere Woreda has acknowledge that the commitment observed on the part of the community in terms of promoting SLM in the respective kebeles in the Woreda is to be appreciated.

Therefore, it can be deduced from this that active community participation is the only opportunity in which almost all of the respondents 189(97.9%) agreed anonymously.

4.7.3. NGO involvement in SLM & SWC

Not only in Tehuledere Woreda, but also in most parts of South Wollo zone, NGO involvement is not satisfactory. As the FGD discussion indicates, the study area is not experienced the active participation of NGOs for a long period. Except food for work (FFW) program operated under the World Bank development program, it is not common to see the involvement of any international or regional development organization. Therefore, it is not surprising that most of the sample households 156(80.8%) respond as there is no NGO who participate in SLM investment in the study area.

The other hope full opportunity is that, to scale up investments in sustainable land management, the Africa Region of the World Bank developed a Strategic Investment Program for Sustainable Land Management in Ethiopia as one of the Sub-Saharan African countries (SSA), that aims to help shift the country's development agenda in favor of more sustainable and climate-resilient land management. Under this program, Ethiopia takes a lion share of the fund due to the various ongoing projects which are being implemented in the country. The discussants indicated that South Wollo zone in general and Tehuledere Woreda in particular has been taken as one relevant and severely affected site. To exploit the opportunity effectively and change the degraded environment in the green economy strategy, the office of agriculture and rural development along with other concerned bodies has already finished the preparation to work with the community.

5. Conclusion and recommendation

5.1. Conclusion

As clearly depicted in the analysis part of this paper, soil erosion and land degradation are found to be the most serious problems and threats to food production, food security, and natural resource conservation in the Tehuledere and the surrounding Woreda. As most of these lands are sloppy, soil loss due to soil erosion is very high removing all the top fertile soils, applied fertilizers, and sown seeds. Farmers are remaining with no or very low harvest when cultivating these vulnerable lands without proper management. Thus, one of the emerging trends in the issue of soil and water conservation, sustainable land management should be an appropriate and viable strategy for the conservation of farm lands.

From the descriptive analysis, focused group discussion, in depth interview and the review of the existing literatures, it was clear that Socio-economic problems, such as large family size and educational status of the household have been found to be the major constraints to scale up SLM technologies. In this regard, the sample populations were entirely illiterate who cannot read and write. Other factors such as farm land characteristics, small land size, sloppy nature of the farm land, physical distance between farmers' residence and farm land area, the kind of technology applicable to a particular farm land, financial constraint to adopt the technology are among the factors hindering the scaling up of SLM technologies. In addition to the above mentioned factors, lack of awareness of the profitability of SLM technology, lack of considerable trust on SLM technologies, lack of access to resource endowment and lack of social capital have been found to be major constraints which hinder the scaling up of SLM technologies in the study area.

The successful scaling up of appropriate SLM technologies in the study area will play a significant role in terms of improving soil fertility, protecting the existing land degradation and soil erosion, maintaining ecological balance, boosting agricultural production, and consequently improve food security of farm households.

Despite such roles SLM plays, a number of causes for food insecurity have been found to be associated with absence of SLM technology adoption and utilization in the study area. These includes Land Degradation and Soil Erosion, Lack of Adequate Rainfall, Low Level Scaling up of SLM technologies i.e. limited application of improved seed, fertilizer (traditional manure and commercial fertilizer), Lack of farm land appropriate to irrigation, and underutilization of pesticides and insecticides among the farmers in the study area.

However, there are promising prospects that indicate the potential in the study area for the promotion of SLM technologies in the long run. These include among other things, the lesser efforts of the government exerted to conserve soil and water, active community participation, Strategic Investment Program for Sustainable Land Management developed with the support of the African Region of the World Bank and NEPAD regional initiative.

5.2. Reccommendation

The study clearly indicated that improving the productivity of highlands, which are prone to soil erosion, without soil conservation is impossible. Therefore, successful scaling up of soil conservation measures and long term sustainable land management technologies. This study therefore suggests to follow the broader approach of Sustainable Land Management (SLM), which aims at ecologically sound, economically viable and socially acceptable recommendations. It which places SWC in a more holistic framework that is closer to farmers' reality. For its practicability, the following points should be taken in to consideration.

- As most of the farm lands are steep slope gradient and mountainous in nature, traditional manure is recommended rather than commercial fertilizer. Avoid the culture of using animal dung for fuel in rural areas is to be encouraged.
- There should be efforts to promote family planning programs to halt population growth, and creating awareness creation campaigns about the profitability of SLM technologies in the study areas.
- In any of the rural development strategies, the integration of SLM and food security should not be seen separately; but more prudent use of external inputs such as fertilizer and improved seeds, and greater emphasis on low external input sustainable land management practices, would be helpful in the effort to make the area at least food secured.
- More than any stakeholder, the government should play an active role in promoting SLM technology and mobilize the community for development. In this regard, the interview result has indicated that every SWC conservation efforts are learnt traditionally. This traditional knowledge should be updated regularly; so that the community will tend to protect the soil. Thus, soil fertility will be improved and the current aid seeking status of food security can be improved.
- One must pay attention to viable physical conservation measures such as stone bunds, soil bunds, terraces, check dams, trees and other measures to protect the top soil from erosion.
- Since, the comparative advantage of people in Tehuledere and the surrounding area is not in input-intensive cereal crop production but more in low input technologies, greater emphasis on developing these technologies in agricultural extension and other development programs is needed.
- DAs, extension workers, land desk officers and the community should be integrated to adopt the culture of water harvesting in each district level. In sloppy and steep nature which has not the access to irrigation, it is essential that the runoff water being disposed through cutoff drains and water ways let into water harvesting structures for domestic use and minor irrigation activities. This will enhance the farm households copping strategy to food shortage.
- One should consider choice of appropriate technologies and approaches. Techniques and technologies to be used should be selected from a number of technical options depending on rainfall, farming

practices, soils types, topography and other relevant features. This clearly indicates that one size fits all system does not work here.

Finally, integrating the existing active community participation, and other regional and international development partners such as NEPAD and World Bank as opportunities to scaling up sustainable land management technologies, further efforts should be invested to change the existing critically sever status of soil erosion and land degradation and widen the prospects of SLM in the study area.

References

Abay, F., Lemma, M., Flynn, P., Waters-Bayer, A., 2001. A Challenge and an Opportunity: Innovation by Women Farmers in Tigray., (un published)

Adesina, A.A., Mbila, D., Nkamleu, G.B., Endamana, D, 2000. Economic analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. Agr. Ecosystem. Env., 80, 255-265.

Alemu, T., 1999. Land tenure and soil conservation: Evidence from Ethiopia. PhD thesis. Dep. Econom., Goteborg University.

Amare, Y., Adale, Y., Tolessa, D., Castro, A.P., Little, P.D., 2000. Food Security and Resource Access: A Final Report on the Community Assessment in South Wollo and Oromya Zones of Amhara Region, Ethiopia. IDR, Addis Ababa University, Ethiopia.

Asfaw, G., 2003. Breaking the current cycle of famine in Ethiopia: natural resource management and drought related famine prevention; Research Paper. Addis Ababa, Ethiopia.

Aune, J.B., Asrat, R., Tulema, B., 2003. Zero tillage/reduced tillage: The key to Intensification of the crop-livestock system in Ethiopia. NORAGRIC. Agr. Univ. Norway. As. Mimeo.

Ayalew, D., Dercon., Gautama, M., 2005. Land tenure insecurity and investment in Ethiopian agriculture: Evidence from panel data. Mimeo.

Barbier, E., 1990. The Farm-level Economics of Soil Conservation: The Uplands of Java. Land Econom., 66, 199-211.

Bauer, D.F., 1977. Household and Society in Ethiopia." Occasional Papers No. 6, African Studies Centre, Michigan State University, East Lansing.

Bekele, E., 2003. Causes and Consequences of Environmental Degradation in Ethiopia. In G.Asfaw (ed.). Env. Env. Change in Ethiopia. Consultation Paper on Environment. Forum for Social Studies, Civil Society. Env. Pol. Dial., Addis Ababa.

Bekele, W., 2004. Economics of soil and water conservation: Theory and empirical application to Subsistence farming in the eastern Ethiopian highlands. PhD thesis. Swedish Univ. Agr. Sci., Uppsala.

Bekele, W., Drake, L., 2003. Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. Ecolog. Econom., 46, 437 - 451.

Belay, T., 2000. Processes and Causes of Accelerated Soil Erosion on Cultivated Fields of South Wollo, Ethiopia. Eastern and Southern Afr. Soc. Sci. Res. Rev.

Benin, S., 2004. Increasing land productivity in high versus low agricultural potential areas: the case of the Ethiopian highlands. International Food Policy Research Institute, Washington. DC. Processed.

Binswanger, H., McIntire, J., 1987. Behavioral and Material Determinants of Production Relations in Land Abundant Trop. Agr. Econom. Dev. Cultur.Change., 36, 75-99.

Bishaw, B., 2003. Deforestation and land degradation on the Ethiopian highlands: A strategy for physical recovery. Res. paper, Addis Ababa, Ethiopia.

Blaikie, P., Brookfield, H.C., 1987. Land Degradation and Society. London: Methuen.

Boetekees, S., 2002. Rural Credit and Soil and Water Conservation: A Case Study in Tigray, Northern Ethiopia. Policies for Sustainable Land Management in the Ethiopian Highlands Working Paper No., 2002-03. Wageningen University and Research Centre.

Blaikie, P., 1989. Explanation and policy in land degradation and rehabilitation for developing countries. Land Degradat. Rehabilitat., 1, pp. 23-37.

Bojo, J., Cassells, D., 1995. Land Degradation and Rehabilitation in Ethiopia: A Reassessment. AFTES Working Paper., No. 17. World Bank, Washington DC.

Boserup, E., 1965. The Conditions of Agricultural Growth. New York: Aldine.

Bosre up, E., 1965. The conditions of agricultural growth. The economics of agrarian Change under Population pressure. Earth scans Publicat., London.

Bowles, S., Gintis, H., 2002. Social capital and community governance. Econom. J., 112,419 - 436.

Braun, A.R., Smaling, E.M.A., Muchugu, E.I., Shepherd, K.D., Corbett, J.D., 1997. Maintenance and Improvement of Soil Productivity in the Highlands of Ethiopia, Kenya, Madagascar, and Uganda. AHI Techn. Rep. Ser., No. 6, African Highlands Initiative (AHI), Nairobi.

Byerlee, D., Spielman, D.J., Alemu, D., Gautama, M., 2007. Policies to Promote Cereal Intensification in Ethiopia: A Review of Evidence and Experience. Inter. Food Policy Res. Inst. Discuss. Paper., no. 00707. Washington, DC: IFPRI.

Central Statistical Agency of Ethiopia (CSA)., 1995. The 1994 population and housing census of Ethiopia. Various summary reports. Federal Democrat. Republ. Ethiop., Addis Ababa.

Chambers, Robert., 1995. Sustainable Rural Livelihoods: A Key Strategy for People, Environment and Development." In The Greening of Aid, edited by C. Conroy an M. Litvin off. London: Earth scan.

Chavas, Jean-Paul., 1995. The Micro-economics of Food Security. Working Paper. Madison. Dep. Agr. Econom., University of Wisconsin.

Coelli, T., Rao, D.S.P., O'Donnell, C., Battese, G.E., 1998. An Introduction to Productivity and Efficiency and Productivity Analysis. 2nd ed. New York: Springer.

Croppenstedt, A., Demeke, M., Meschi, M.M., 2003. Technology adoption in the presence of constraints: The case of fertilizer demand in Ethiopia. Rev. Dev. Econom. 7 (1), 58–70.

De Graaff, J., Amsalu, A., Bodna, F., Kessler, A., Posthumus, H., Tenge, A., 2008. Factors influencing adoption and continued use of long-term soil and water conservation measures in five developing countries. Appl. Geogr., 28, 271-280.

Degefa Tolessa., 1996. Belgcrop production as a strategy of households' food security: A comparative study of belggrower and non-belggrower farmers in Munessa Woreda, Arssi Region. Unpublished M. A. thesis. Dep. Geogr., Addis Ababa University.

Dejene, A., 2003. Integrated Natural Resources Management to Enhance Food Security: The Case for Community-based Approaches in Ethiopia." FAO Environment and Natural Resources Working Paper 16. Food Agr. Organizat., (FAO) of the United Nations, Rome.

Deininger K., Jin, S., Adenew, B., et al., 2003a. Market and Non-Market Transfers of Land in Ethiopia: Implications for Efficiency, Equity, and Non-Farm Development. World Bank Policy Res. Work. Paper., 2992.

Demeke., Meschi, M.M., 2003. Technology Adoption in the Presence of Constraints: The Case of Fertilizer Demand in Ethiopia. Rev. Dev. Econom., 7(1) 58-70.

Demeke, A.B., 2003. Factors Influencing the Adoption of Soil Conservation Practices in Northwestern Ethiopia. Discussion Paper 37. Inst. Rur. Dev., University of Gottingen.

Desta, L., Carucci, V., Wendem-Agenehu, A., Abebe, Y., (eds.)., 2005. Community Based Participatory Watershed Development: A Guideline. Addis Ababa. Min. Agr. Rur. Dev.

Desta, L., Kassie, M., Benin, S., Pender, J., 2001. Land Degradation in the Highlands of Amhara Region and Strategies for Sustainable Land Management. Working Paper No. 32. Livest. Policy Analys. Program, International Livestock Research Institute (ILRI), Addis Ababa.

Douglas, M., 1994. Sustainable Use of Agricultural Soil: A review of prerequisites for success or failures. Dev. Env. Rep. No.11 Centre for Dev. Env. Bern Switzerland: University of Bern.

EEA/EEPRI (Ethiopian Economic Association/Ethiopian Economic Policy Research Institute)., 2006. Evaluation of the Ethiopian Agricultural Extension with Particular Emphasis on the Participatory Demonstration and Training Extension System (PADETES). Addis Ababa, Ethiopia: EEA/EEPRI.

Ersado, L., Amacher, G., Alwang, J., 2003. Productivity and Land Enhancing Technologies in Northern Ethiopia: Health, Public Investments, and Sequential Adoption. Env. Product. Technol. Division Discussion Paper No. 102. Washington, DC. Inter. Food Policy Res. Inst. (IFPRI).

Feder, G., Just, R., Zilberman, D., 1985. Adoption of agricultural innovations in developing countries: A survey. Econom. Dev. Cultur. Change., 33(2), 255-298.

Fischer T., Turner, N., Angus. J., McIntyre, L., Robertson, M., Borrell, A., Lloyd, D., 2004. New Directions for a Diverse Planet: Proceedings of the 4th International Crop Science Congress. Brisbane, Australia, 26 September–1 October 2004.

Franken Berger, Timothy., Coyle, P.E., 1993. Integrating Household Food Security into Farming Systems Research/Extension. J. Farm. System. Res. Extens., 4 (1), 35-65.
Food and Agriculture Organization (FAO)., 2008. Web site. Conservation Agriculture. http://www.fao.org/ag/ca/. Accessed April 2014.
Gebremedhin, B., Pender, J., Ehui, S., 2003. Land Tenure and Land Management in the Highlands of Northern Ethiopia. Ethiop. J. Econom., 8(2), 47-63.
Gebremedhin, B., Swinton, M., 2003. Investment in Soil Conservation in Northern Ethiopia: The Role of Land Tenure Security and Public Programs. Agr. Econom., 29. 69-84.
Gebremedhin, B., Swinton, M., Tilahun, Y., 1998. Effects of Stone Terraces on Crop Yields and Farm Profitability: Results of On-farm Research in Tigray, Northern Ethiopia. J. Soil Water Conservat., 54(3), 568-573.
Grepperud, S., 1996. Population Pressure and Land Degradation: The Case of Ethiopia. J. Env. Econom. Manag., 30. 18–33.
Getachew Diriba., 1995. Economy at the crossroad: Famine and food security in rural Ethiopia. Addis Ababa. Care Int. Ethiopia.
Goeschl, T., Igliori, C.D., 2006. Property Rights for Biodiversity Conservation and Development: Extractive Reserves in the Brazilian Amazon. Dev. Change., Vol. 37, No. 2, 427 – 51.
Gronvall, M., 1995. Environmental profile of Ethiopia. Swedish Inter. Dev. Author. (SIDA), Stockholm, Sweden.
Hagos, F., 2003. Poverty, institutions, peasant behavior, and conservation investment in northern Ethiopia. PhD thesis No. 2003:2. Dep. Econom. Soc. Sci., Agr. Univ. Norway, As.
Hagos, F., Pender, J., Gebreselassie, N., 1999. Land Degradation in the Highlands of Tigray and Strategies for Sustainable Land Management." Socioeconomic and Policy Research Working Paper No. 25. Livest. Analys. Project., Inter. Livest. Res. Inst. (ILRI), Addis Ababa.
Hailu, Z., Runge-Metzger, A., 1993. Sustainability of land use systems. The potential of indigenous measures for the maintenance of soil productivity in Sub- Saharan agriculture. A rev. methodol. Res., Weikersheim: Margraf.
Herweg, K., 1993. Problems of Acceptance and Adaptation of Soil Conservation in Ethiopia. Top. Appl. Res. Manag., 3, 391-411.
Hoben, A., 1995. Paradigms and Politics: The Cultural Construction of Environmental Policy in Ethiopia. World Dev., 23(6), 1007-1021.
Holden, S.T., Benin, S., Shiferaw, B., Pender, J., 2003. Tree Planting for Poverty Reduction in Less-favored Areas of the Ethiopian Highlands. Small-scale Forest Econom. Manag. Policy., 2(1), 63-80.
Holden, S.T., Shiferaw, B., 2002. Poverty and Land Degradation: Peasants' Willingness to Pay to Sustain Land Productivity." In C.B. Barrett, F.M. Place, and A.A. Aboud (eds.). Natur. Res. Manag. African Agr. Understanding and Improving Current Practices. New York. CABI publish. Associate. Inter. Centre for Res. Agr. (ICRAF).
Holden, S.T., Shiferaw, B., Pender, J., 2004. Non-farm Income, Household Welfare, and Sustainable Land Management in a Less-favored Area in the Ethiopian Highlands. Food Policy., 29, 369-392.
Holden, S.T., Johannes, H., 2002. Land Redistribution, Tenure Insecurity and Input Intensity: A Study of Farm Households in Southern Ethiopia. Land Econom., 78, 573- 590.
Hurni, H., 1988. Degradation and Conservation of Resources in the Ethiopian Highlands. Mount. Res. Dev., 8(2/3), 123-30.
Hurni, H., 1993. Land Degradation, Famines and Resources Scenarios in Ethiopia. In: Pimental, D. (ed.). World Soil Erosion and Conservation. Cambr. Stud. Appl. Ecol. Res. Manag. Cambr. Univ. Press., pp. 27-62.
Hurni, H., 1988. Degradation and conservation of the resources in the Ethiopian highlands. Mount. Res. Dev., 8(2/3), 123-130.
Hurni, H., 1988b. Principles of soil conservation for cultivated land. Soil Technol., Vol. 1: pp. 101-116.
In. C., Reij., Waters-Bayer, A., (eds.), Farmer Innovation in Africa. A Sour. Inspirat. Agr. Dev. London: Earthscan.
Kaliba, A.R.M., Rabele, T., 2004. Impact of Adopting Soil Conservation Practices on Wheat Yield in Lesotho. In Managing Nutrient Cycles to Sustain Soil Fertility in Sub- Saharan Africa, edited by A. Bationo. Nairobi, Kenya: CIAT. Trop. Soil Biol. Fertility Inst.
Kappel, W., 1996. Economic analysis of soil conservation in Ethiopia: Issues and research perspectives. Center Dev. Env., University of Bern. Cited in Ethiopia: Soil fertility initiative concept paper. Food Agr. Organizat. United Nat., Rome.

Karkee. K., 2004. Effects of deforestation on tree diversity and livelihoods of local community: A case study from Nepal. Master Thesis. University of Lund, Sweden.

Kassie, M., Yesuf, M., Köhlin, G., 2008. The Role of Production Risk in Sustainable Land Management Technology Adoption in the Ethiopian Highlands. EfD Discussion Paper 08-15. Washington, DC. Res. Future.

Kassie, M., Holden, S.T., 2005. Parametric and non-parametric estimation of soil Conservation adoption impact on yield in the Ethiopian Highlands. Dep. Econom. Res. Manag. Norweg. Univ. Life Sci.

Keeley, J., Scoones., 2000. Knowledge, Power and Politics: The Environmental Policy-Making Process in Ethiopia. J. Modern African Stud., 38(1), 89-120.

Kinfe, A.W., 2002., Public and Private Labor Investment and Institutions for Soil and Water Conservation in Tigray, Northern Ethiopia. Polic. Sustainable Land Manag. Ethiopian Highlands Working Paper No., 2002-02. Wagen. Univ. Res. Center, Wageningen.

Lemma, K., Gebre-Hiwot, Y., 1999. The food security situation in Ethiopia: Concepts, status and trends. In the proceedings of the First National Workshop of NOVIB Partners Forum on Sustainable Land Use, Addis Ababa.

Knack, S., Keefer, K., 1997. Does social capital have an economic payoff? A cross country investigation. Quart. J. Econom., 112, 1251-1288

Lee, D.R., 2005. Agricultural Sustainability and Technology Adoption: Issues and Policies for Developing Countries. Amer. J. Agr. Econom., 87(5), 1325–34.

Lötscher, m., 2003. Status und Dynamik der land wirtschaftlichen Produktion und Produktivität in einem Kleineinzugsgebiet in Maybar, Wollo, Äthiopien. MSc. thesis. Universtät Zürich.

Martha Nagash., 2000. Environment depletion as a way out to seasonal food insecurity: The case of North Wollo, Ethiopia. A paper presented for the First RLDS International Policy Research Workshop, Addis Ababa, April 14 - 15, 2000.

Maxwell, S., 1994. Food Security: A Post-Modern Perspective. IDS working Paper, no. 9. Brighton: University of Sussex. Inst. Dev. Studies.

McNeill, J.R., Wniwartez, V., 2004. Breaking the Sod: Humankind, History, and Soil. Sci., Vol. 304, pp. 1627-1628.

Mesfin Wolde Mariam., 1984. Rural vulnerability to famine in Ethiopia, 1958-1977.New Delhi: Vikas Publishing House.

Million, T., Belay, K., 2004. Adoption of Soil Conservation Measures in Southern Ethiopia: The Case of Gununo Area. J. Agr. Rur. Dev. Trop. Subtrop., 105(1):49-62.

Ministry of Agriculture (Moa)., 2013. Sustainable Land Management Project Phase - Ii Resettlement Policy Framework (Rpf) Final (Revised _ Final)., Addis Ababa.

Mulat D., Ali, S., Jayne, T.S., 1997. Promoting fertilizer use in Ethiopia: The implications of improving grain market performance, input market efficiency. farm manag.

Nyssen, j., Poesen, j., Myersons, j., Deckers, j., Mitiku Haile., Lang, A., 2003a. Human Impact on the Environment in the Ethiopian and Eritrean Highlands – a state of the art. Earth Sci. Rev., 64(3-4): pp. 273-320.

Nyssen, j., Mitiku, H., Myersons, j., Poesen, j., Deckers, j., 2004a. Environmental Policy in Ethiopia: A rejoinder to Keeley and Scoones. J. Mod. Afr. Stud.

Current Practices, edited by C. B. Barrett, F. M. Place, and A. A. Aboud. Wallingford, U.K: CAB International.

Ogbasellasie, S., 1995. Agricultural sector development policies and strategies in Ethiopia. Ministry of Agriculture, Government of Ethiopia.

Okumu, B.N., Jabbar, M.A., Colman, D., Russell, N. 2002.A bio-economic model of integrated crop-livestock farming systems: The case of Ginchi watershed in Ethiopia. In Natur. Res. Manag. Afr. Agr. Understand. Improv.

Olarinde, L., Oduol, J.B., Binam, J.N., Diagne, A., Njuki, J., Adekunle, A.A., 2011. Impact of the Adoption of Soil and Water Conservation Practices on Crop Production: Baseline Evidence of the Sub Saharan Africa Challenge Programme. Middle-East J. Sci. Res., 9 (1), 28–40.

Pender, J., Kerr, J., 1998. Determinants of Farmers' Indigenous Soil and Water Conservation Investments in India's Semi-arid Tropics. Agr. Econom., 19, 113– 25.

Pender, J., Gebremedhin, B., 2007. Determinants of Agricultural and Land Management Practices and Impacts on Crop Production and Household Income in the Highlands of Tigray, Ethiopia. J. Afr. Econom., 17, 395–450.

Pender, J., Gebremedhin, B., 2007. Determinants of Agricultural and Land Management Practices and Impacts on Crop Production and Household Income in the Highlands of Tigray, Ethiopia. J. Afr. Econom., 17, 395–450.

Pender, J., Gebremedhin, B., Benin, S., Ehui., 2001. Strategies for sustainable land Agricultural development in the Ethiopian highlands. Amer. J. Agr. Econom., 83(5), 1231-1240.

Pender, J., Gebremedhin, B., 2004. Impacts of Policies and Technologies in Dry land Agriculture: Evidence from Northern Ethiopia." In S.C. Rao (ed.), Challenges and Strategies for Dry land Agriculture. Amer. Soc. Agr.(ASA) Crop Sci. Soc. Amer. (CSSA) Spec. Publicat., 32. Madison: ASA and CSSA.
Pender, J., Gebremedhin, B., Benin, S., Ehui, S., 2001. Strategies for Sustainable Development in the Ethiopian Highlands. Amer. J. Agr. Econom., 83(5), 1231-40.
Pender, J., Gebremedhin, B., Haile, M., 2003. Livelihood strategies and land management Practices in the highlands of Tigray. Presented at the Conference on Policies for Sustainable Land agement in the East African Highlands, April 24-26, 2002, United Nations Economic Commission for Africa, Addis Ababa (revised). Inter.
Food Pol. Res. Inst. (IFPRI), Washington, DC.
Plateau, J.P., 1996. the Evolutionary Theory of Land Rights as Applied to Sub-Saharan Africa: A Critical Assessment. Dev. Change., Vol. 27, No. 1, 29–86.
Rahmato, D., 2003. Littering the Landscape: Environmental Policy in Northeast Ethiopia." In T.J. Bassett and D. Crummy (eds.), African Savannas. Global Narrat. Local Know. Env. Change. Oxford: James Curry.
Reijntjes, C., Haverford, B., Waters-Bayer, A., 1992. Farming for the Future: An Introduction to Low-External Input Susta. Agr., London: MacMillan Press.
Rockstrom, J., Barren., Fox, P., 2002. Rainwater management for increased productivity among small-holder farmers in drought prone environments. Phys. Chem. Earth., 27, 949-959.
Sanchez, P.A., Shepherd, K.D., Soule, M.J., Place, F.M., Buresh, R.J., Izac, A.N., Mokwunye, A.U., Kwesiga, F.R., Ndiritu, C.G., Woomer, P.L., 1997. Soil fertility replenishment in Africa: An investment in natural resource capital. In replenishing soil fertility in Africa, ed. R.J. Buresh, P.A. Sanchez, and F. Calhoun. Madison, Wisc. Soil Sci. Soc. Amer., Inc. Amer. Soc. Agr., Inc.
Sandez, S., 2008. Implications of Land Tenure on Food Sufficiency in Dang District, Master Thesis: M-06-02, Purbanchal Univ.
Sen, A., 1981. Poverty and famine: An essay on entitlement and deprivation. Clarendon Press.
Sen, A., 1981. Poverty and Famines: An Essay on Entitlement and Deprivation. Oxford: Clarendon Press.
Setegn, S., Srinivasan, R, Dargahi, B., Melesse, A., 2009. Spatial delineation of soil erosion vulnerability in Lake Tana basin, Ethiopia. Division of Hydraulic engineering, Department of land and water resources engineering. Roy. Inst. technol. Case study, Stockholm, Sweden.
Shaxson, T.F., 1988. Conserving Soil by Stealth, in W. C. Moldenhauer, and N. W. Hudson (eds), Conservation Farming on Steep lands, Ankeny, Iowa.Soil Water Conservat. Soc. World Assoc. Soil Water Conservat.
Shibru, D., 2003. An investigation of the Physical and Socio-economic Determinants of Soil Erosion in the Hararghe Highlands, East Ethiopia. Land Degradat. Dev., 14, pp. 69-81.
Shiferaw, B., Holden, S.T., 1998. Resource Degradation and Adoption of Land Conservation Technologies in the Ethiopian Highlands: A Case Study in Andit Tid, North Shewa. Agr. Econom., 18, 233-247.
Shiferaw, B., Holden, S.T., 1999. Soil Erosion and Smallholders' Conservation Decisions in The Highlands of Ethiopia. World Dev., 27.
Shiferaw, B., Holden, S.T., 2000. Policy Instruments for Sustainable Land Management: The Case of Highland Smallholders in Ethiopia. Agr. Econom.
Shiferaw, B., Holden, S.T., 2001. Farm-level Benefits to Investments for Mitigating Land Degradation: Empirical Evidence from Ethiopia. Env. Dev. Econom.
Shiferaw, B., Holden, S.T., 2003. Poverty, resource scarcity, and incentives for soil and water conservation: Analysis of interactions with a bio-economic model. Pres. 25th Internat. Confer. Agr. Econom., August 16-22, 2003, Durban, South Africa.
Shiferaw, A., Singh, K., 2010. An Appraisal of the Challenges that Affect Sustainability and Productivity of the Land Use in the Borena Woreda of South Wollo Highlands, Ethiopia. J. Susta.Dev. Africa.
Shively, G.E., 1998. Impact of Contour Hedgerows on Upland Maize Yields in the Philippines. Agr. System., 39(1), 59–71.
Stoorvogel, J., Smaling, E.M.A., 1990. Assessment of soil nutrient depletion in Sub-Saharan Africa: 1983-2000. Rep. No., 28, Wageningen, the Netherlands.
Sutcliffe, J.P., 1993. Economic Assessment of Land Degradation in the Ethiopian Highlands: A Case Study. Addis Ababa, Ethiopia: Transitional Government of Ethiopia. Min. Plann. Econom. Dev., Nat. Conservat. Strat. Secretar.

Steiner, K.g., 1996. Causes of soil degradation and development approaches to sustainable soil management. Margraf Verlag, Reiskirchen.

Swinton, S.M., 2000. More social capital, less erosion: Evidence from Peruvian Altiplano. Select. paper annu. meet.Amer. Agr. Econom. Assoc., Tampa, FL, and July 30-Aug. 2, 2000.

Tadesse, M., Belay, K., 2004. Factors influencing Adoption of soil conservation measures in Southern Ethiopia: The case of Gununo Area. J. Agr. Rur. Dev. Trop. Subtrop., 105, 49-62.

Taffa, T., 2009. Characteristics of Property Units in Ethiopia, the Case of Two Pilot Projects in Amhara National Regional State. Nord. J. Survey. Real Estate Res., 6(2),7-24. http://dx.doi.org/10.1017/ S0376892900007955.

Tefera, B., Ayele, G., Atnafe, Y., Jabbar, M.A., Dubale, P., 2002. Nature and Causes of Land Degradation in the Oromya Region: A Review." Socio-economics and Policy Research Working Paper 36. Inter. Livest. Res. Inst., (ILRI), Nairobi.

Teklewold, H., 2004. Risk and time preferences on soil conservation decision in the central Ethiopian highlands of Ethiopia. MSc thesis. Addis Ababa Univ.

Tiffen, M., Mortimer, M., Gichuki, F., 1994. More people, less erosion: Environmental recovery in Kenya. New York: John Wiley & Sons.

Titola. T., 2008. Environmental degradation and its implications for agricultural and rural development: The issue of land erosion. J. Susta. Dev. Africa., 10(2), 1-31

Webb, P., et al., 1992. Famine in Ethiopia: Policy implication of the coping failure at national and household levels. Research Report 92. Washington D. C. Inter. Food Policy Res. Inst.

Wiebe, K., 1994. Household Food Insecurity and Resource Use. In International Agriculture and Trade Reports: Africa and the Middle East. Washington, D.C. Econom. Res. Serv., U.S. Dep. Agr.

WFP (World Food Programme), Ethiopia., 2005. Report on the cost-benefit analysis and impact Evaluation of soil and water conservation and forestry measures (draft). Manag. Env. Res. Enable Transit. More Susta. Livel., Addis Ababa.

World Bank., 2004. Four Ethiopians: A Regional Characterization. Assessing Ethiopia's Growth Potential and Development Obstacles. Draft background report to the Country Economic Memorandum, May 24th. Addis Ababa.

World Bank., 1986. Poverty and Hunger: Issues and Options for Food Security in Developing Countries. Washington, D.C.: World Bank.

World Bank, Washington, D.C., 2003b. Tenure Security and Land-related Investment: Evidence from Ethiopia. World Bank Pol. Res. Work. Paper 2991. World Bank, Washington, DC.

WCED (World Commission on Environment and Development)., 1987. Our Common Future. Oxford, UK: Oxford University Press. Also available at: http://www.un-documents. Net/wced-ocf.htm; accessed on 19 February 2014.

Yared, A., 1999. House hold resources, strategies and food security: A study of Amhara households in Wagada, Northern Shewa. Addis Ababa: AAU Printing Press.

Yared, A., et al., 2000. Food security and resource access: A final report on community assessments in South Wollo and Oromya Zones of Amhara Region, Ethiopia. Addis Ababa: IDR/BASIS.

Yamane, T., 1967. Statistics, an Introductory Analysis, 2nd Ed, New York: Harper and Row.

Yesuf, M., 2004. Risk, time, and land management under market imperfection: Applications to Ethiopia. PhD thesis. Dep. Econom. Goteb. Univ.

Yilma, M., Ayalneh, B., Workneh, N., 2010. Rural Household Food Security Status and Agricultural Practices in Assosa District. In Proc. 12thAnnu. Confer. Agr. Econom. Soc. Ethiop. September 2010, Ethiopia, Addis Ababa.

Yirga. C., Hassan. R., 2009. Social costs and incentives for optimal control of soil nutrient depletion in the central highlands of Ethiopia. Available from: www.elsvier.com. (Accessed: 08/11/2014).

Zikhali, P., 2008. Fast-Track Land Reform and Agricultural Productivity in Zimbabwe. Working Papers in Economics, No. 322. Gothenburg, Sweden. Univ. Gothenburg. Dep. Econom.