SOIL EROSION, DEFORESTATION AND RURAL LIVELIHOODS IN THECENTRAL RIFT VALLEY AREA OF ETHIOPIA: A CASE STUDY IN THE DENKU MICRO-WATERSHED OROMIA REGION

by

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Submitted in accordance with the requirement

for the degree of

MASTER'S IN HUMAN ECOLOGY

at the

UNIVERSITY OF SOUTH AFRICA

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June, 2011

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DECLARATION BY CANDIDATE AND SUPERVISOR

I hereby declare that the dissertation, **SOIL EROSION, DEFORESTATION AND RURAL LIVELIHOODS IN THE CENTRAL RIFT VALLEY AREA OF ETHIOPIA: A CASE STUDY IN THE DENKU MICRO-WATERSHED OROMIA REGION,** submitted for the Master's degree in Human Ecology to the College of Agriculture and Environmental Sciences, Department of Agriculture, Animal Health and Human Ecology, UNISA, is my own original work and has not previously been submitted to any institution.

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ACKNOWLEDGEMENTS

This research would not have been possible without the continued support of Israel Dibaba, an expert in soil and water conservation in Adama district who approached the households to participate in interviews, and helped me to collect the data throughout the period. Thanks go to my wife, Azalech Kassaye, for sharing the burden of entering the data into the computer. I also appreciate and thank Kedir Shemsu, for assisting and providing me with the software SPSS.12.0 which was used for the analysis of the data and also Dr. Weldamlak Bewket, my supervisor, who instructed me in the use of the software for the analysis of the research data and overall guidance. My heartfelt appreciation and thanks are extended to Prof, Elsa Albertse, my co-supervisor, for her invaluable assistance in reviewing and commenting on the content and layout of the dissertation.

LIST OF ACRONYMS AND ABBREVIATIONS

^{0}C	DEGREE CELCIUS
E	EAST
FAO	FOOD AND AGRICULTURAL ORGANIZATION
GIS	GEOGRAPHIC INFORMATION SYSTEM
ha	HECTARE
MASL	METRES ABOVE SEA LEVEL
mm	MILLIMETRES
MOARD	MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT
N	NORTH
SWAT	SOIL AND WATER ANALYSIS TOOL
UNEP	UNITED NATIONS ENVIRONMENTAL PROGRAM
UNSLE	UNIVERSAL SOIL LOSS EQUATION
USD	UNITED STATES DOLLAR
WB	WORLD BANK

ABSTRACT

This research was conducted in one of the districts in the Oromia region located in the Central Rift Valley to assess the problem of soil erosion and deforestation and to determine how these drivers of land degradation affect the livelihoods of farmers. The research was a case study undertaken in an identified micro-watershed making use of the questionnaire interview method. A household sample was obtained using a simple random sampling technique; Information interviews were conducted with community representatives, district level experts and development agents who worked in the community. The objective of the research was to assess the levels of soil erosion and deforestation and the impact on the livelihoods of the community. Research methods were questionnaire and direct observation. The results of the study indicated that the effects of soil erosion and deforestation on land productively, agriculture and livestock production at large, had a negative effect on livelihoods of the community members. Recommendations based on the research affirm the necessity to undertake large-scale natural resource management starting with community-based watershed management thereby reducing the impact of land degradation on livelihoods of farmers and ensuring food security and sustainable land management.

Key words: soil erosion, deforestation, land degradation, farmers, livelihoods, natural resource management, Central Rift Valley, Denku watershed, Oramia, Ethiopia

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Chapter 1
Introduction

1.1. Background

Ethiopia, situated in Horn of Africa, has an area of about 1.1 million square kilometers. With a population of 80 million, Ethiopia is the second most populous country in Africa (Argaw, 2005:24; Berhe, 2004:12; Bishaw, 2003:1). Land degradation, caused by soil erosion and deforestation, presents an obstacle on agriculture hence threatening the rural livelihoods in the country. Bliake as cited in Bekele and Draike (2003:1) emphasize that Ethiopia is the area most detrimentally affected by soil erosion in the world. Both wind and water erosion removes the fine organic particles in the soil leaving behind large particles and inert stones. Valetin and Bresson as quoted by Ries (2009:1) indicate that soil sealing and crusting, as well as resulting reduced infiltration capacity and sparse vegetation cover, lead to increased overland flow and even higher erosion rates.

Ethiopia is an agrarian country with over 85 % of its population residing in rural areas. The subsistence agricultural sector engages nearly 85 % of the work force (Bekele, 2001:4**).** In Ethiopia soil erosion by water that contributes significantly in food insecurity in rural households, constitutes a real threat to the sustainability of the existing subsistence agriculture (MoARD, 2009:6; Yirga; 2007:52, Hurni, *et al.* as quoted by Bewket, 2006:404; Amede *et al.* 2001:14).

Yirga (2007:52) notes that over the last decades, agricultural production and income growth in Ethiopia have lagged behind population growth consequently; per capita food production, income and savings have dropped. Disturbingly, in the highlands, soil, the basic natural resource on which the livelihood of the majority of the population is based, has been progressively impoverished. Swift and Wooms as quoted by Amede *et al*. (2001:14) note that the main threat to the sustainability of smallholder farmers is the depleted soil organic matter caused by soil erosion. Most of the Ethiopian cultivated lands fall prey to soil erosion as the traditional farming system is still in use and sustainable land management systems have not been adopted at scale it would have been.

Deforestation is major problem in Ethiopia as the people rely on biomass energy for cooking.

1.2. Purpose of study

1.2.1. Major purpose of the study

The major purpose of this research was to assess the major causes of soil erosion and deforestation, and to gain an understanding of how deforestation and soil erosion affect livelihoods of rural farmers. A case study approach was adopted in a micro-watershed in the Oromia region.

1.3. Objectives of the study

The main objectives of the study are to explore how soil erosion and deforestation affect livelihoods of farming communities. Soil erosion and deforestation are the main forms of land degradation responsible for the decline in land productivity in turn reducing income of farm households in Ethiopia. Specific objectives of the study are:

- To determine the major causes of soil erosion and deforestation through interviews with both farmers and experts, as well as through observation and expert judgment.
- To analyze and interpret the links between soil erosion and deforestation and the livelihoods of the farming households based on the findings obtained from the interviews and observation.

1.4. Research questions

The study aims to answer the following questions:

- What is the relationship between soil erosion and deforestation, and the livelihoods of farming rural communities in the selected area?

- Do soil erosion and deforestation affect the income of farmers thereby threatening their livelihoods?

1.5. Problem statement

Ethiopian agriculture and the livelihoods of rural community have been affected by land degradation the major drivers of which are soil erosion and deforestation. Soil erosion depletes soil fertility and reduces land productivity which in turn reduces the farm level income of households. Reduction in fertility of soil results in poor water holding capacity of the soil and vegetative growth of crops are limited as a result particularly during decrease in the quantity of seasonal rain fall. Decrease in soil fertility leads to increase in farm level investment. Biomass energy being the dominant source of energy of rural Ethiopia, deforestation has affected the livelihoods of farmers because households are expected to travel long distances to collect fuel wood. The study micro-watershed has been affected by soil erosion and deforestation as a result of poor management of the resources.

The study area is located in rift valley where the ecosystem is very fragile and hence soil erosion and deforestation are severe. The soil type within the study area is dominated by sandy soil which is easily washed away through both wind and water erosion. Continuous cultivation with little protection measures exacerbated the level of soil erosion and hence land productivity has declined significantly. Deforestation is also a serious problem within the study area as the households are relying on forest products for cooking. Reforestation activities are not successful because of the semi-arid nature of the area and deforestation activities have removed the natural vegetation and households are expected to travel long distances to get the remaining tree. Both problems have been affecting the livelihoods of the study area for decades.

1.6. Significance of the study

Knowledge of the potential negative impacts of soil erosion and deforestation on the livelihoods of the farming communities is prerequisite to designing programmes and

projects to implement sustainable land management systems nationally, to reduce the degradation of land, to ensure sustainable agriculture and to improve food security among farming communities. The decreasing fertility of the soil leading to demand for chemical fertilizers to compensate for the loss of organic matter through soil erosion has been a pressing issue among rural communities. The rising cost of chemical fertilizer is particularly worsening for the farmers as many cannot afford them.

The study is vital because the problems relating to soil erosion and deforestation negatively affect the livelihoods of framers. Soil erosion reduces drastically the productive potential of farms through impoverishment of the soil. Deforestation, besides altering the natural environment, affects the access of households to wood for fuel and construction. Rural households rely mainly on the forest products for energy. Therefore, an understanding of the impact of soil erosion and deforestation on the livelihoods of farmers will enable policy makers and development partners of the government to plan and implement programmes and projects to alleviate both problems thereby increasing livelihoods. In this research, understanding the level of knowledge of the community of soil erosion, deforestation and the associated negative impacts on their livelihoods is essential in the development and implementation of natural resource management programmes.

1.7. Organization of the dissertation

Chapter 1 presents the introduction/background, objectives and significance of the study. In chapter 2, relevant literature on soil erosion and deforestation is cited. Chapter 3 provides a description of the study area including location, socio-economic and demographic characteristics of the population, as well as climate, research design, data collection methods and sampling, materials and methods. In chapter 4 results obtained from the research and discussion of the analysis is presented. Chapter 5 will provide conclusions and recommendations based on the findings of the study

Chapter 2

Literature Review

2.1. Introduction

As the problem of soil erosion on the livelihoods of rural communities presents a global challenge, it is receiving concerted attention from the scientific community and governments. In developing countries, where agriculture is a main source of livelihoods and a significant contributor to the economy, soil erosion poses a common threat. This problem is crucial in Ethiopia since it limits agricultural production through decreased soil fertility negatively affecting the livelihoods of the farmers. The following literature review supports this idea.

A livelihood comprises the capabilities, assets (financial, natural, social, and physical, human) and activities required to provide a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation. It also contributes net benefits to other livelihoods at local and global levels in the short and long term (Krantz, 2001:5)

A conceptual framework (Figure 1) indicating the negative effect of soil erosion and deforestation of the livelihoods of farmers follow-

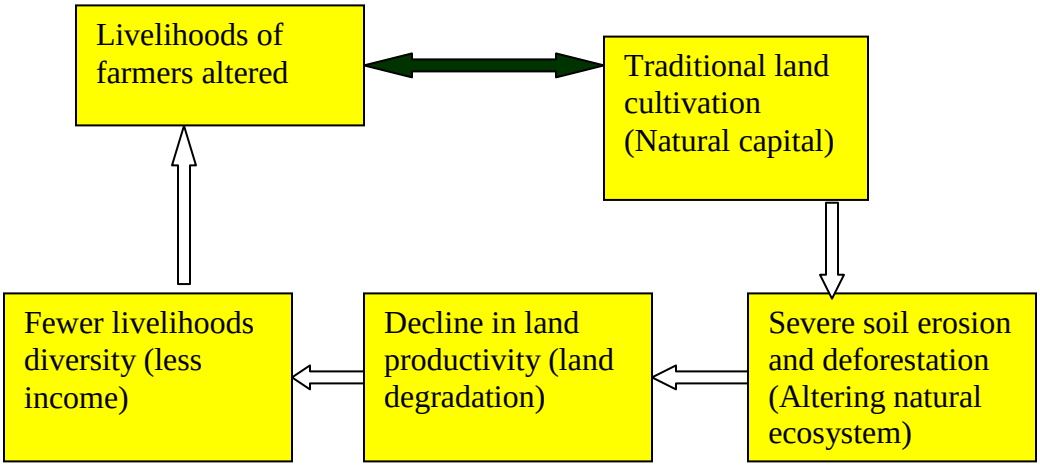

Figure 1: Conceptual framework to indicate the negative effects of soil erosion and deforestation on livelihoods

The traditional system of land cultivation entails over-utilization of the natural resource base leading to soil erosion and deforestation which in turn affect the livelihoods of the farmers. This can be attributed to the fact that soil erosion diminishes soil fertility resulting in decline in land productivity. Similarly, deforestation depletes the supply of wood for fuel and construction.

Land cultivation is the main livelihood of the farming community members that constitute 85% of the Ethiopian population (World Food Program, 2005:1). Soil erosion and deforestation are serious problems that affect land productivity and threaten the livelihoods of majority of the country's population. The recurrent drought that has prevailed since the 1980s and its negative impact on rural livelihoods have been aggravated by soil erosion and deforestation.

As indicated on the conceptual framework, the primary resource of livelihoods of rural communities is agriculture, and agriculture in Ethiopia is predominantly traditional. Appropriate natural resource management interventions have not been undertaken on any significant scale. Severe soil erosion and deforestation affect the livelihoods of farmers directly. Soil erosion depletes the productive potential of land leading to a decline in agricultural production, while deforestation forces farmers to travel long distances to get wood for fuel and construction. This means farmers loose productive time that could be spent on agricultural practices.

2.2. Soil erosion

While topsoil takes centuries to develop, the World's growing human population has actively depleted this resource over decades. As a non-renewable resource and the basis for 97 % of all food production, strategies to prevent soil depletion are critical to ensure sustainable development, (Pimental as quoted by Cohen, Brown, & Shepherd, 2005:249).

Brehane and Mekonen (2009:58) maintain that growing populations and loss of soil mean in many parts of the world are exhausting this critical resource.

Soil erosion is a physical process of soil degradation and the most widespread form of land degradation Lal as quoted by Argaw (2005:20). It is the detachment and transportation of soil particles from one place to another with a degree ranging from splash erosion to the alarming stage of gully formation. Shaxon *et al.* (1997:11) and Miller and Donahue (1997:437) describe the process as a loss of nutrient rich clay and organic matter in rain-drop splashes, impoverishing the upper top soil and while subsequent erosion peels-off the upper soil layers. Tripathi and Singh (2001:10) state that soil erosion that can be called the creeping death is a worldwide problem.

Montgomery (2007:13288) is of the opinion that the recognition of the detrimental influences of accelerated soil erosion on agrarian societies dates back to Plato and Aristotle. Several classic studies have attributed the bare rocky slopes of the classic world to soil erosion in current times. Furthermore, Pimentel, *et al.* (1995:1117) states that soil erosion is a major environmental and agricultural problem worldwide. Although erosion has occurred throughout the period of agricultural activity, it has intensified in recent years.

Soil erosion is a complex process that involves soil properties, ground slope, vegetation rainfall and intensity (Montgomery, 2007:13288). Soil erosion occurs when soil is exposed to water or wind energy. Rain drops hit exposed soil with great energy and launch soil particles along with the water in to the air. Rain drop splash and resulting sheet erosion remove the thin film of soil from the land surface (Pimentel & Kounang, 1998:417). Soil erosion therefore impacts agricultural production negatively by depleting nutrients needed for plant growth. Hartemink (2006:1614) reports that in tropical regions where many soils have inherent low fertility that is concentrated in the top soil, loss of top soil by soil erosion results in a serious reduction in soil chemical fertility.

The intense and increased pressure on land leads to its degradation and pollution, in particular, resulting in a complete loss of its productive capacity (Bellayan, 2000:8). Land degradation is the reduction in capacity of the land to produce benefits from land use that falls under a specified form of land management (Blaikie & Brookfield as quoted by Muchena *et al.* 2004:23); Blaike & Brookfield as quoted by Haile, Herweg & Stillhardt (2006:20), Scherr & Yadav (1996:8) Amsalu (2006:4)

The impact of land degradation and the depletion of soil resources have profound economic implications for low-income countries. Environmental damage results in loss of current income and increased risk, and particularly affects the poor; degradation of land resources reduces the prospects of economic growth and threatens future human welfare, (Barbeer, 1995:1). Furthermore, soil loss has ecological and economic consequences such as nutrient depletion, degraded soil structure and loss in organic matter that affects agricultural livelihoods. Erenstein as quoted by Tibebe and Bewket (2010:1) stated that the economic and social effects of soil erosion are more severe in the developing countries than in developed countries because of the direct dependence for livelihoods of the majority of the population on agriculture and land resources. However, Boardman *et al.* (2009:1) are of an opinion that in developed nations, although starvation or eviction may not be serious threats, annual price rises and failure to respond to these by governments, communities and development partners could lead to financial disaster.

Todate economic analysis of the effects of soil erosion have focused on two aspects of the problem, namely the decline in soil fertility with the resulting loss in agricultural productivity and the pollution of sediment load in water courses. The on-site effect of soil erosion is twofold. First, it reduces soil fertility, thereby affecting crop productivity. Secondly it leads to increased production costs to maintain the level of agricultural production on the farm (Calatrava, Franco & Gonzalez, 2005:1). Zheng *et al.* (2005:85) maintain that soil erosion, in addition to causing on-site loss of top soil and reducing the productivity of the land, is responsible for major off-site environmental effects such as water body pollution and eutrophication. Eaton, (1996:8) reports that soil erosion is considered by many to pose a threat in long-term viability of agriculture in many parts of the world.

Erosion-induced loss in soil productivity is a major threat to global food and economic security, especially among resource-poor farmers. It not only diminishes the quality of soil resources but also makes earning a living from the land increasingly difficult. Reduced productivity of soil, affects outputs such as crop yields derived from the renewable nutrient system of the biosphere (Pimentel *et al.* 1995:1117); Oldeman (2000:1); Herath (2001:97); Stocking (2003:1); Scher & Yadav as quoted by Abegunde *et al.* (2006:2); Boardman *et al*. (2009:1).

Soil erosion is a global environmental and economic problem causing loss of fertile top soil and reducing the productive capacity of the land there-by putting at risk global food security. It also impacts negatively on the natural water storage capacity of catchments areas service of man-made reservoirs and dams, quality of surface water, aesthetic landscape beauty and ecological balance in general (Lal as quoted by Bewket & Teferi, 2009:609). Between 30% and 50% of the World's arable land has been significantly affected by soil loss (Pimentel as quoted by Cohen & Shepherd, 2006:250).

In addition, Muchena *et al.* (2004:23) report that 65% of African agricultural land comprising 31% permanent pasture land and 19% forest and wood-land has been degraded. The report further indicates that water and wind erosion, respectively, account for 46% and 38% of total soil degradation in Africa. Pimentel *et al.* (1995:1117) report that soil erosion rates are highest in Asia, Africa and South America, averaging 30 to 40 tons per hectare per year. More specifically, Maas and Caria-Oliva as quoted by Pimentel *et a*l. (1998:418) report that 100-200 tons of soil have been impoverished per hectare per year in croplands, either by rainfall or by wind or by a combination of these. Ahmed as quoted by Tripathi and Singh (2001:11) estimate that on average 0.5 centimeter of soil and sediment is washed away every year from the land surface. Besides reducing the productivity of crops, soil erosion also damages through flooding. Tripathi and Singh (2001:18) report that crop damage particularly at the seedling stage by runoff water is often serious.

Globally 1.96 billion hectares of land are affected by human-induced soil degradation, mainly by water and wind erosion (Oldeman, 200:2). Another aspect of the problem is that the amount of river-borne soil carried into the oceans has increased from 9.9 billion tons per year before the introduction of agriculture, grazing and related activities, to the

present rate of 26.5 billion tons a year, Judson as quoted by Brhane & Mekonen (2009:58). This figure, however, differs from that reported by Pimentel *et al.* (1995:1117) who estimate a rate of 75 billion tons of soil removed a year by water and wind erosion, most from agricultural land. Haile *et al.* (2008:20) note that the unchecked degradation of soil can deplete its productive capacity for human purposes until steps are taken to stop further degradation and restore fertility.

Bliake as quoted by Bekele and Draike (2003:1) described Ethiopia as the most seriously affected soil erosion area in the world. Both wind and water erosion selectively have removed the fine organic particles in the soil and left behind large particles and stones (Pimental *et al*. 1998:420). Valetin and Bresson as quoted by Ries (2009:1) state that soil sealing and crusting, as well as resulting reduced infiltration capacity and sparse vegetation cover, lead to increased overland flow and to higher erosion rates.

In Ethiopia soil erosion by water contributes significantly to food insecurity among rural households and poses a real threat to the sustainability of the existing subsistence agriculture, (Amede *et al.* 2001:4; Hurni, *et al.* as quoted by Bewket, 2006:404; Haile *et al.* 2006:24; Yirga, 2007:52; Desta *et al.* 2009:6; Hurni as quoted by Tibebe *et al.* 2010:1). Studies have shown that soil erosion and land degradation are not new phenomena in the Ethiopian context. Shiferaw and Holden as quoted by Bekele (2003:2) report that soil erosion in Ethiopia is not a new phenomenon. It is as old as the history of agriculture itself. However, the problem first received official attention after the devastating famine in 1973/74. Yirga and Hassan (2009:1) report that soil degradation is considered to be one of the most important natural resource management issues in Ethiopia. FAO as quoted by Osman, Skowronek and Sauerborn (2008:1) emphasize that progressive land degradation threatens the agro-ecology, crops and pasture particularly, water erosion, overgrazing and poor management of land are degrading agents with a significant impact on crop production.

In addition, Boardman as quoted by Brehane *et al.* (2009:59) cites that water erosion is a major factor in land degradation that affects the physical and chemical properties of soil and results in on-site nutrient loss and off-site sedimentation of water resources. Further to their discussion, Hurni, Sutcliffe and Tamene, as quoted by Brehane *et al.* (2009:59)

note that soil erosion by water and its associated effects are recognized as severe threats to the national economy of Ethiopia and, since 85% of the country's population depend on agriculture for their livelihoods, physical soil and nutrient losses inevitably lead to food insecurity.

Among the various types of soil degradation, soil nutrient depletion due to net nutrient extraction by crops and nutrients lost along with eroded soil, is a concern to subsistence farmers in Ethiopia. Bojo and Casells as quoted by Yirga *et al.* (2009:1) noted that depletion of soil fertility resulting from soil erosion, leads to declining crop yields and a rise in the number of people who do not have food security. Hurni as quoted by Haile *et al.* (2006:22) report that all physical and economic evidence shows that land resource productivity is a serious problem in Ethiopia with the continued population growth the problem is going to escalate in the future.

Titilola (2008:6), Descorois, *et al.* (2008:327) report that the predominant cause of land degradation and soil erosion stem from excessive human pressure or poor management of the land specifically overgrazing, over-cultivation of crop land and deforestation. Additionally, Setegn *et al.* (2009:1) note that poor land use practices, improper management systems, and a lack of appropriate soil conservation measures have played a major role in land degradation in Ethiopia.

Yirga (2007:52) indicates that over the last decades, population growth has outstripped agricultural production and income growth in Ethiopia. Consequently, per capita food production, income and savings have been falling. In the highlands, soil, the basic natural resource on which the livelihood of the majority of the population is based, has been degraded progressively. Likewise, Swift and Wooms as quoted by Amede *et al.* (2001:14) state that the main obstacle to sustainability of subsistence farmers is the depleted soil organic matter caused by soil erosion.

The major problem caused by soil erosion in Ethiopia is the quantity of soil removed each year and detrimental effects on the region and the population. From studies carried

out so far, there is evidence that the problem is seriously affecting areas and populations that rely on land cultivation for their livelihoods. As reported by Yirga (2007:6), soil erosion has become the most pressing natural resource issue imposing on-site costs for individual farmers in terms of reduced yield and off-site costs to society. External factors such as pollution of wetlands through sediments and excessive soil loss rate, reach 100 tons per hectare per year.

Another dimension of the problem is that the quantity of soil lost each year varies depending on the different agro-ecological zones. Haile *et al.* (2006:22) indicate that soil erosion which is particularly severe in Ethiopia is the major indicator of loss in soil fertility. The average annual loss from agricultural lands is estimated at 130 tons per hectare per year in the highlands. However, Amede, Belachew and Geta (2001:2), Bezuwerk, Tadesse and Getahun (2009:1) report that the degradation and loss of soil resulting from soil erosion in Ethiopian highlands is estimated at about 200 tons per hectare per year.

Hurni, as quoted by Pender, Place and Simon (1999:11), Bekele *et al.* (2003:1), Berhe (2004:14), Alemayeyu and Yohanes and Dubale (2006:10) report that erosion is most severe in cultivated lands with an average loss of 42 tons per hectare per year. Furthermore, the long-term impact of soil erosion on livelihoods of farmers is the area of land that is rendered unproductive. The FAO as quoted by Bewket (2006:4) indicates that in a national study carried out in mid-1980s, it was estimated that soil erosion depleted the soil in some 20,000 to 30,000 hectares of crop lands annually was projected that around 10 million highland farmers would have had their land rendered inert by the year 2010.

Additionally, as reported by Haile *et al.* (2006:22), the FAO as quoted by Kassie *et al.* (2008:5), crop yield is expected to decline between 1-3% while the population growth rate is 3.3%.Water erosion was the most important process and in the mid-1980s, with 27 million ha or almost 50% of the highland area significantly eroded, 14 million hectare seriously eroded and over 2 million hectares beyond reclamation. Further on his report, Sonneveld as quoted by Bewket (2006:4) states that the cost of soil erosion for the national economy is around USD 1.0 billion per year.

2.3. Deforestation

FAO and UNEP as quoted by Karkee (2004:12), defined deforestation as the removal or damage of vegetation in the forest to the extent that it no more support its natural flora and fauna. In other words, deforestation is the transformation of forest land to non-forest land. Forest land that includes lands under agro-forestry and shifting cultivation is not surely closed-canopy primary forests. Bishaw (2003:1) indicates that forests and the benefits they provide in the form of wood, food, income and watershed protection against land degradation have an important and critical role to play in enabling people to secure a stable adequate food supply.

Forest resources contribute directly to the livelihood of 90% of the 1.2 billion people in the developing world that live in extreme poverty (Baird as quoted by Culas, 2006:8). Deforestation is another form of land degradation that affects the livelihoods of people in general and the rural poor in particular. Brosius as quoted by Angelsen and Balcher (2005:1384) report that the disappearance of natural forests in developing countries is a major problem because it negatively affects the livelihoods of people dependent on forest products and services.

Additionally, as noted by Claus (2006:429), deforestation impacts economic activity and threatens the livelihood and cultural integrity of forest-dependent people at local level. Deforestation reduces the supply of forest products and leads to siltation, flooding and soil degradation. Yasuka and Levins (2007:450) are of the opinion that clearing forests and the subsequent agricultural development has a detrimental effect on every element of local ecosystems such as microclimate, soil and aquatic conditions, and most significantly, the ecology of local plants and animals including human disease factors.

Ethiopian farmers and a significant number of urban dwellers depend solely on biomass energy for cooking and in some cases even for lighting. Wood is therefore vital sources of domestic energy besides the need for construction and production of farm implements and household furniture. Bekele (2001:10) maintains that the energy sector remains

heavily dependent on wood for fuel. Wood provides 78 % of the energy required, while dung and crop residues provide 16 %. Additionally, Asfaw (2003:11) reports that a marked feature of Ethiopia's energy sector is the high proportion about 93% of biomass energy relative to modern forms of energy consumption.

However, deforestation and land degradation are rapidly becoming the most serious problems in rural Ethiopia where the majority of the population live and depend on the forest products for energy. Tumbe, Mulenga and Husselman (2005:5), Schereckenberg, Luttrell and Zorlu (2007:12) state that forests fulfill central role in rural livelihoods, providing a wide range of products and services for subsistence use, cash income, and safety nets in times of need. In particular, rural households depend on forest and wood land resources to meet their energy needs, to provide construction and roofing materials, and to provide fodder for livestock. In addition wild fruits ensure healthy diet as well as a supply of medicinal plants.

Deforestation and land degradation in Ethiopia are impeding the capacity of forests and land to contribute to food security and to provide other necessities such as fuel wood and fodder. According to Bisahw, (2003:1) the increasing population of Ethiopia has resulted in excessive forest clearing for agricultural use, overgrazing and exploitation of the existing forests for fuel wood, fodder and construction materials. The forest areas of the country have been reduced from 40% a century ago to less than 3%.

Deforestation has many far-reaching consequences. The environmental functions and services of the forest ecosystem are reduced or even lost depending on the level of deforestation. While deforestation reduces biological diversity, it increases soil erosion and the siltation of rivers and streams can endanger hydroelectric schemed (Karkee, 2004:13; Kaimowtz, 2003:3; Brosius as quoted by Sunderlin, Balcher, Bergers, Santoso, Wunder, 2005:3184) note that deforestation depletes the natural resource of poor rural households who rely on wild fruits, vegetables, bush meat, medicinal plants, wood for fuel, and timber. Illegal forestry activities also negatively impact environmental services

vital to rural households such as the provision of clean water, pest and disease control, pollution and regulation of the climate, stream flow, and ground water levels.

Asfaw (2003:8) describes deforestation as continued land clearing for agriculture due to an exploitive farming system, tree cutting for fuel, logging due to population growth accompanied by stagnating agricultural production, a lack of alternative energy and a lack of security of tenure which precludes long-term land improvement measures. Studies conducted by different researchers indicate that deforestation has already reached alarming proportions. The situation has been exacerbated by the rising demand for wood and the benefits it provides. Consumption of wood for fuel occurs not only in rural areas, but also in urban areas. Area attributed to deforestation stands at 150, 000 to 200,000 hectares per year, (FAO as quoted by Bishaw (2001:1), WB as quoted by Haile *et al*. (2006:22) and Berhe (2004:18).

2.4. Summary of the literature review

Relevant literature indicates that both soil erosion and deforestation are worldwide phenomena. These drivers of land degradation affect negatively as water supply, crop production, availability of wild fruits, nutrient recycling and moisture retention that an ecosystem should provide. Although in developed nations, the problems of soil erosion and deforestation may not be directly linked to impact negatively the livelihoods of the community, these can be responsible for reduced economic growth. In developing countries, where agriculture is the predominant source of livelihoods, both problems affect rural livelihoods through depleting the productive potential of the soil thereby reducing farm income. Ethiopia is one of the most serious cases as agriculture is the major source of sustainable livelihoods and is the largest contributed to the gross domestic product of the country.

Chapter 3

Research methods

3.1. Introduction

The livelihood of rural people is directly linked to the utilization of land resources for food production, energy sources and shelter. Mismanagement of these resources reduces the livelihoods of those who are dependent on these resources. The majority of the Ethiopian population (85%) relies on land resources for their livelihood, mainly through land cultivation (Bekele, 2001:4). The traditional system of land cultivation has led to the removal of the productive top-soil hence a decline in land productivity, which has negative economic and environmental implications. The demand for wood both to build houses and for fuel contributes to the depletion of the resources. This imbalance between the natural regeneration and removal of the resources exacerbates land degradation thereby placing a strain on the livelihoods of households. Therefore, further exploration of the causes of soil erosion and deforestation and linking these problems to livelihoods of the farming communities of Ethiopia can make a vital contribution to local knowledge and community development planning.

The research methods involved both qualitative and quantitative data collection, analysis and answering the questions in the problem statement related to the negative effect of soil erosion and deforestation on the livelihoods of farmers. Sources of data included household interviews, key informant interviews both with representatives of the community in the study area, and experts working at the district office of agriculture, direct field observation, comparing the study area with its severe degradation with those areas where soil conservation and reforestation activities have been undertaken, as well as informed judgment by the researcher (relevant knowledge from previous studies and experience).

3.2. Research design

The design of the research comprises selecting a watershed as a study area, sampling of respondents from the study area through simple random sampling to participate in the interviews and conducting information interviews with community representatives, district (*woreda*) level experts and development agents. Field observation and expert judgment also form part of the research methodology. The questions to be answered in this research are the links between soil erosion and deforestation, and the livelihoods of farmers and how these causes of land degradation affect the livelihoods of farmers. Field observation and informed judgment, by the researcher, are also part of the research methodology. Informed judgment is to mean that the previous experience and educational background in relation with the negative impact of soil erosion and deforestation on the livelihoods of farmers was used.

The study employed the case study research design. A micro-watershed covering an area of 565 ha was selected as the case study site. It is located in the Rift Valley of Ethiopia, where the environment is characterized by a fragile ecosystem and heavy population pressure. Soil erosion and deforestation are widespread. Furthermore, within the study area (micro-watershed), a limited amount of land reclamation (reducing soil erosion, reforestation) and livelihood diversification activities have been in operation since 2002.

3.3. Data collection methods and sampling

3.3.1 Measuring instrument design

Face to face interview using questionnaires was adopted to gather information on the problem of soil erosion and deforestation from households, key informants including community representatives; experts at District office of Agriculture and development agents who are assigned at community level. The questionnaire was developed with the objective of obtaining meaningful information and views from the household members living within the study area and from the key informants. Before the actual data

collection, the questionnaire was tested for validity by pilot study and selection among households.

The data for the study was collected using a questionnaire distributed to sample households, focus group discussions, key informant interviews and field observation. The survey was used to generate quantitative data from sample households and key informants in the watershed area, and qualitative data from focus group discussion to gather information from the community watershed development planning team (a team composed of five women and five men who are appointed by the community to manage land rehabilitation activities). Additionally, focus group discussion was used to discuss the problem with experts working in the district office of the Agriculture ministry and development agents working within the community. Training and guidance were provided to the enumerators on how to conduct the interviews.

3.3.2. Sampling

A simple random sampling method was used to select sample households for the household survey. A total of 141 households selected from the total of 220-population sample in the study site; interviews were conducted on three levels: district expert level, development agent level and farmers' level (including household interviews) and planning team interviews. The researcher used field observation, to compare the severely degraded area with that at which soil conservation and reforestation activities have been undertaken to reduce the severity of soil erosion and deforestation. Expert judgment from previous studies and experience was also used.

3.4. Description of the study area

3.4.1. Location

The study area, namely the Denku micro-watershed, is located in the Adama district of East Showa Zone, Oromia National Regional State of Ethiopia. The area is located in the Ethiopian Rift Valley, 110 km from Addis Ababa (the capital city). It is about 10 km

from the capital of the district, Adama, in the Southeast. The research site in Ethiopia is featured in Figure 2 below

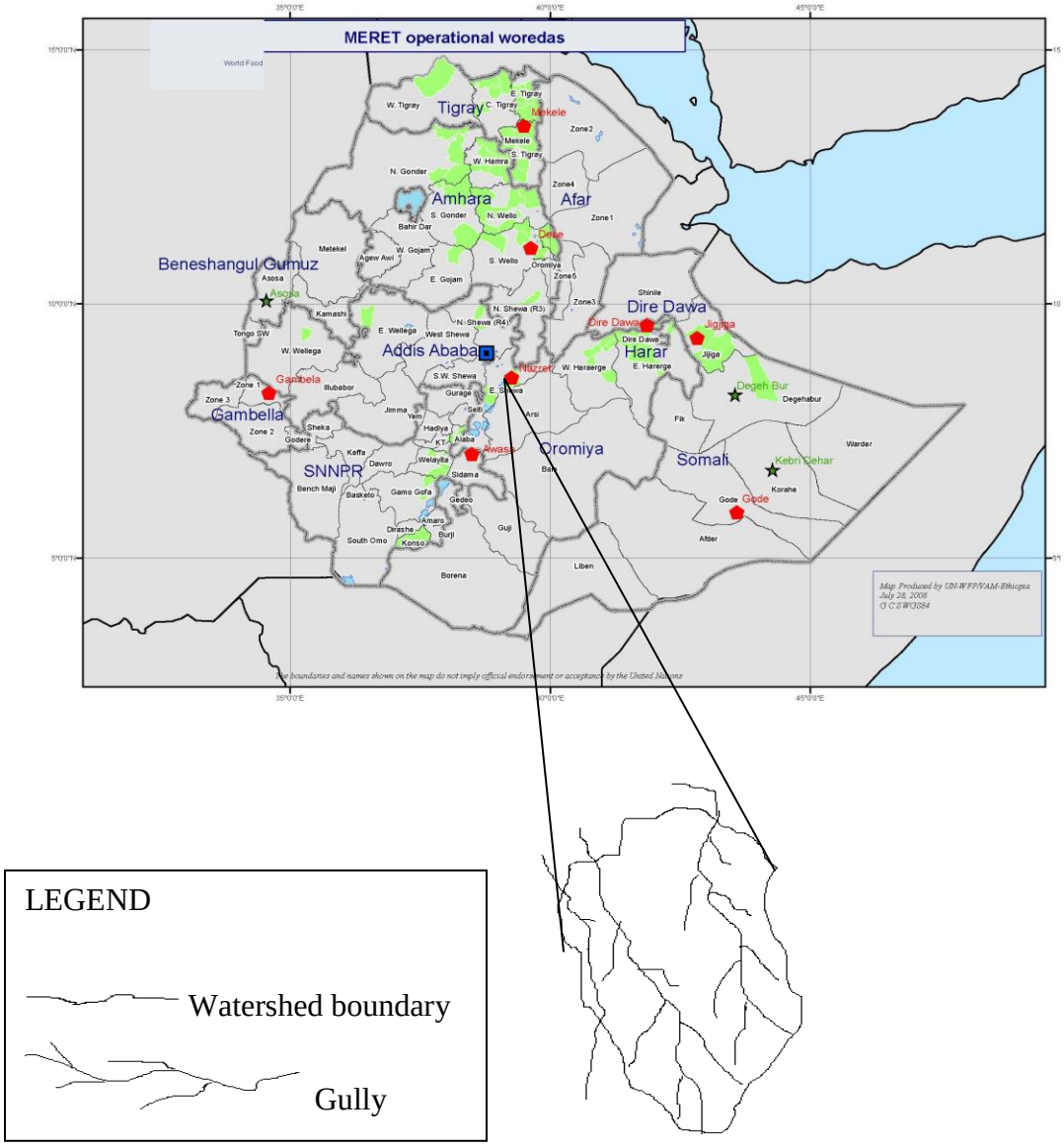

Figure 2: Location of the study area

3.4.2. Physiographic characteristics

The Denku micro-watershed covers an area of 565 ha. Elevation ranges from 1500 m to 1650 masl (meters above sea level). The topography of the area in which the cultivated land and settlements are located is dominated by reasonably gentle slopes ranging from 3

per cent to 15 per cent and with hilly areas having a slope ranging from 20% to 85%. More than 85% of the total area is cultivated land (MoARD, 2010). As the area is located within the Rift Valley, the geology is characterized by high drainage rocks which are pervious and highly drained soils. The soil type is dominated by sandy and sandy loam which is highly susceptible to erosion. The high porosity of the soil has resulted in the absence of surface water within the study area presenting a challenge to harvest and store rainwater. This is because the soil hardly retains rain water for long but rather infiltrates down easily because of the coarse nature of the texture.

After years of over-utilization of the natural resources and over-cultivation, there are no forest areas in the micro-watershed. There are obvious signs of soil erosion with numerous wide gullies both in the cultivated lands and hilly areas. Except for a very few indigenous acacia trees scattered in the cultivated lands, no forest exist as a result of years of deforestation. Given its geology, the level of ground water table can be as deep as 300 to 400 meters (MoARD, 2010), and it contains strong concentrations of elements such as fluorine (Ministry of Water Resources and Energy, 2010).

This makes almost impossible to have water both for household use and livestock. As a result of this the community members are forced to travel an average of 10 km to get water. Fetching water for households is mostly done by women and children. Long-term deforestation has resulted in the absence of wood for fuel which forces the community either to travel very long distances to collect fuel wood or use cow dung and crop residues for cooking with the resultant loss in soil fertility.

3.4.3. Climate

The district receives an annual precipitation of 600 mm (Agricultural Research Centre, 2010). The rainfall pattern is characterized by torrential and intense rain during the onset of the rainy season, with a prolonged dry spell during the rainy season which normally occurs from end of June to mid-September. The temperature of the area ranges from 15^0 C to 30^0 C, as recorded in the district capital. Wind speeds are very high during the dry

season, increasing the level of evaporation and transpiration. This makes planting and growing plants (trees) very challenging. Agriculture is also affected as a result of this phenomenon, since the rate of loss in soil moisture is very high. The major seasons in the study area include Meher, Belg and dry seasons, the former two names being local names one indicating relatively longer rainy season (Meher) and one a very short rainy season (Belg). The longer rainy season is usually between end June to mid-September, while the short rainy season is from mid-March to April. The remainder of the year is dry season.

3.4.4. Socio-economic context

The study area has a total population of 1300 grouped in to 220 households. The predominant source of livelihood is agriculture, with few people engaged in as small traders in addition to their farming operations. The major crops grown in the area include tef, the staple grain, haricot beans, and maize. The major growing season is the Meher, the most productive (dominant) season in the country. Having only one productive agricultural season is one of the reasons, coupled with severe soil erosion and deforestation, that the population of the area is often faced with food shortages.

According to the District Agricultural office, the land holding size of the farmers in the district ranges from 1.75 hectares to 3.25 hectares, though there are an estimated 20% landless households (MoARD, 2010). Although the livelihoods of this latter section are the most challenged, this problem is often not addressed. In addition, this segment of the population in rural Ethiopia is dominantly engaged in deforestation for charcoal and wood for fuel to generate income as part of their livelihoods. Furthermore, land encroachment (cultivating non-arable land such as hilly areas and marginal lands) is dominated by those who are landless which in turn aggravates the level of land degradation. Among the sample households land-holding size varied between 0.25 and 4 ha.

In relation to infrastructural services, there is a community-built road that links the study area to the nearest town Adama, though there is no public transport. People travel on foot

to gain access to the town. However, other services such as agricultural extension, health and education, are available as the community-built road allows government and non-governmental organizations to access the areas easily for service delivery. There is a school which caters for children up to grade six after which they have to travel 10 kilometers to Adama, the capital of the district. Availability of water in the study area, both for human and livestock consumption is one of the major challenges because the community members have to travel to the nearest water point nearly 7 kilometers from the area. Health services present another problem in the study area as community members need to travel 10 kilometers to the district capital whenever they need medical treatment.

The lowest administrative structure of government is the village level administration which is managed by the members of the community who are elected locally and termed the Kebele administration. The Kebele administration is responsible for all the political and economic administration of the territory that is supported by the assigned development agents. The strongest traditional organization available in the study area, as in any part of the country, is *Edir*, an organization established by the community itself which is tasked with managing funerals. Although, membership is voluntary with a strong traditional leadership which has its own management structure is in evidence. Each member of the organization has to contribute a set amount either weekly or monthly based on the decision reached by the general assembly.

There is also another traditional financial organization, known as *Ekub*. In this traditional organization members are organized according to their own interests and they contribute money either weekly or monthly. The size of an *Ekub* depends entirely on the decision made by the members who wish to get organized. There is a chairperson to manage redistribution but the members decide on how frequently the redistribution of the money contributed should occur. This is usually done on a monthly basis. Each member has an equal chance of receiving the collected money and the recipient is decided by a lottery. After each member has collected a redistribution of the collected cash, which is usually

used for different expenses at household level, the process continues based on the decision of the members.

3.4.5. Soil erosion

Figure 3: Gully erosion

The above photo was taken of the study area during field observation and interviews with the members of the community planning teams. As is clearly shown, gully erosion is a serious problem in the study area. It cuts the land three ways. The first is the expansion of the gully side- ways that takes away farm lands and reduces the size of farm plots. The second one is head cut where the gully increases in length in the field. The third is the increase in the depth of the gully, which almost blocks communication between villages and households within the same village. The other impact is increase in the depth of gully that drains moisture from the adjacent farm plots. This affects availability of moisture for the crops to be grown. During unexpected intense storms, huge quantities of water from the gully damage crop field down-stream and causing loss in income.

3. 4. 6. Deforestation

Deforestation is one of the serious problems in the study area as observed during the site assessment and observation. Most of the hillsides are devoid of vegetation as a result of continued destruction of the natural forests without management and protection. Farmers within the study area have to travel long distances to chop down the first available tree to obtain wood for fuel and construction. Deforestation has serious far-reaching consequences including natural habitat exhaustion, desertification, altering the natural hydrological cycle, water run-off and aridity of specific areas that pose serious problems to practicing profitable agriculture. Increase in surface run-off with severe erosion and land dissection, will exacerbate the condition of the already fragile agro-ecosystem and cause damage to infrastructure and settlements. As this phenomenon is wide-spread with in the study area, farmers are unable to reach adequate levels in agricultural production to earn their livelihoods.

The below picture was taken of the study area which illustrates the extent of deforestation. Previously the hillside was covered with natural forest before being seriously deforested by continued cutting down of the indigenous trees. During the rainy season, almost 80% of rain water becomes run-off water and the land below the hillside area is washed away exacerbating the problem of soil erosion. Gully formation is the result of this phenomenon resulting in the whole agro-ecosystem being seriously affected. Medicinal trees have disappeared with loss of both forest diversity and agro-biodiversity being common problems. Farmers have initiated actions to reverse these trends and some signs are evident indicating reversal of the problem is a possibility.

Figure 4: Deforestation

Some reforestation activities have been observed in the study area and the picture shows that deforested areas can be reforested and natural regeneration can be supported. Planting of trees can be well managed and so that there is not slide-back to the problem.

Figure 5: Reforestation

3.5. Data collection and analysis

To explore the effects of soil erosion and deforestation on the livelihoods of farmers, Adama District was selected. This District is located in the Oromia region, the biggest region in the country. The largest part is situated in the central Rift Valley area, which has a very fragile ecosystem with highly degraded soil and significant deforestation. After having identified the district, a study area was selected paying attention to level of land degradation, accessibility and availability of previous interventions in areas of soil conservation and reforestation. The livelihoods of the people in the selected district are subsistence agriculture. This sector is characterized by over-use of resources, soil, water (rain) and forest clearly indicating the negative effects of erosion and deforestation on the farmers living in the study micro-watershed. Rain-fed agriculture presents a challenge in the selected micro-watershed as the area is subject to sandy soils and with very erratic rainfall, uneven distribution and high wind speed as a result of the absence of wind-breaks.

3.5.1. Measuring instruments for data collection

To generate efficient information on the negative impacts of soil erosion and deforestation on the livelihoods of farmers both qualitative and quantitative interviews were taken according to three categories. The first category entails interviews with sample households living in the area. Household members who were interviewed were identified by simple random sampling. The total number of households living in the study area was 220 of whom 141 households were identified for the interview. A detailed questionnaire, to gain adequate information on soil erosion and deforestation, was developed and used for the interviews with the identified households.

The interviews with the identified households were conducted by enumerators (development agents who live and work with the community in the study area and experts who work in the District Office of Agriculture). The second category was key informant interviews with the representatives of the community living in the designated area. Community representatives; 10 in number (50% of each gender), are mandated to lead development interventions such as soil conservation, reforestation and rain water harvesting. A check-list was prepared and used to facilitate the collection of sufficient information on soil erosion and deforestation on the livelihoods of farmers. This discussion was led by the researcher unlike the interviews with the households.

The third category concerned focus group discussions. One group comprised district level experts, with professions in natural resource management, agronomy and animal husbandry as well as development agents who lived and worked within the area with the same professions as those of the experts. Each focus group had 6 group members (three experts and three development agents).The researcher handled the discussion with this group and adequate information in relation to the negative impacts of soil erosion and deforestation on the livelihoods of the farmers was generated. The purpose of gathering information on the negative impacts of soil erosion and deforestation on the livelihoods of farmers, from different sources, was two-fold. The first was to ensure a diversity of information and the second triangulation of the information gathered.

A questionnaire was used for household interview and key informant interview as this is the most efficient way of obtaining views from farmers. One week before the actual data collection, the researcher provided training to the enumerators on the content of the questionnaire and procedure to be followed at each interview. As the villages were spread over two areas and the enumerators needed to visit household members in their homes, five days were needed to complete the interviews of household members. The key informant interview was handled by the researcher and it took him one full day to complete the interviews with the ten community planning team members, with 50% of each gender. Focus group discussion with experts and development agents was also handled by the researcher. During the interviews with the households, data clearing was undertaken on a daily basis to avoid and/or to minimize loss of data.

3.5.2. Data analysis

The data from field interviews with households and key informants were analyzed using SPSS 12.0 software. The information gathered included the perception of the respondents of the existence of soil erosion and deforestation and to determine what the consequences of soil erosion and deforestation were in cutting land productivity through depleting soil fertility with reduced farm income. The analysis was also based on age categories and gender to see whether there were different attitudes towards the problem and perceptions of the different age groups of the problem of soil erosion and deforestation on the livelihoods of the farmers. Size of land ownership, of livestock, the difference in use of chemical fertilizers now and 20 years previously provided additional data for the analysis.

Data obtained from the focus group discussion, which was qualitative, were analyzed through discussions and what the focus group had to say about their perception and understanding of the problem of soil erosion and deforestation on the livelihoods of farmers with in the study area was documented. The views of all the members of the focus groups (experts, and development agents were classified and analyzed after which the information was combined with the results from the interviews with households and

key informants. During data analysis, as there are some households who do not respond to some of the questions, the total number of households is therefore less than 141 in some of the tables used.

Chapter 4

Results and discussion

4.1. Introduction

The results from the household interviews, key informant interviews with the representatives of the community and focus group discussion with the experts from the district office of agriculture, are presented. Additionally, field level observation and expert judgment by the researcher, with skills from previous education and experience in the field of soil erosion and deforestation have been incorporated. The level of soil erosion and deforestation, in areas where soil conservation and reforestation activities have been undertaken, was compared with areas where soil erosion and deforestation have not been addressed. This comparison was found to be in line with the results from the interviews of households, key informants and focus group discussion.

The overall results show that the problem of soil erosion and deforestation in affecting livelihoods of farmers do provide some answers to the research questions namely:

1. What is the relationship between soil erosion and deforestation and the livelihoods of farmers in rural communities in the selected area?

2. Do soil erosion and deforestation affect the income of farmers thereby threatening their livelihoods?

The answers to these questions are in line with literature cited. For instance (FAO, 2009) reported that the negative impacts of soil erosion, including the removal of nutrient rich topsoil in upland areas and subsequent reduction of agricultural productivity in those areas affected livelihoods of farmers.

4.2. Socio-demographic characteristics

The total number of households lived in the area was 220, of which 141 households were selected through simple random sampling. From the sampled households, 82.3% were male-headed households and 17.7% were female-headed households (Table 1). The eldest sons of female- headed households, who were not mature enough to plough land because of their age and weakness ploughed their lands with oxen, or they have to contract other men to plough for which service they had to pay.

Table 1: Gender of respondents

Gender	Frequency	Per cent
Male	116	82.3
Female	25	17.7
Total	141	100

Table 2 below indicates that the age of respondents ranged from 19 to 65 years with an average of 43.5 years. The age range of the respondents is so divers that there has been good information gathered in relation with the problem of soil erosion and deforestation.

Table 2: Age of respondents (years)

Age	Frequency
Average	43.5
Minimum	19
Maximum	65

Figure 6 below indicates the impact of soil erosion on livelihoods as observed by the different household age groups. Coping strategies and options for responses were: reduced number of daily meals, reduced quantity of food per meal, withdrawal of

children from school, poor health and marginal land cultivation. The most commonly occurring impacts were: reduced quantity per meal, reduced number of daily meals, marginal land cultivation and withdrawal of children from school. These actions clearly show that the effect of soil erosion has serious social and economic repercussions for rural households relying on land cultivation. This finding is in line with what was reported by Yirga, (2007:6), namely that soil erosion has become the most important natural resource problem imposing on-site costs to individual farmers in order to maintain yield.

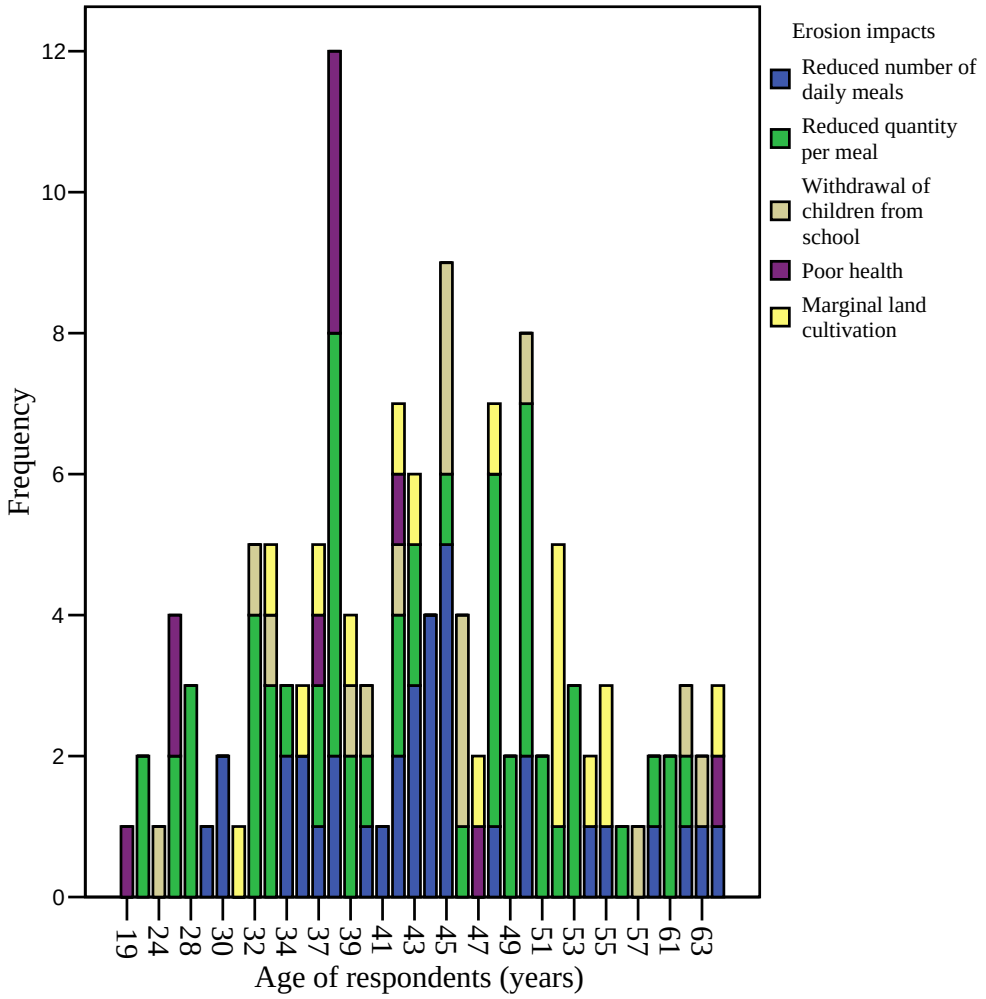

Figure 6: Age of respondents and their response on the impact of soil erosion on their livelihoods

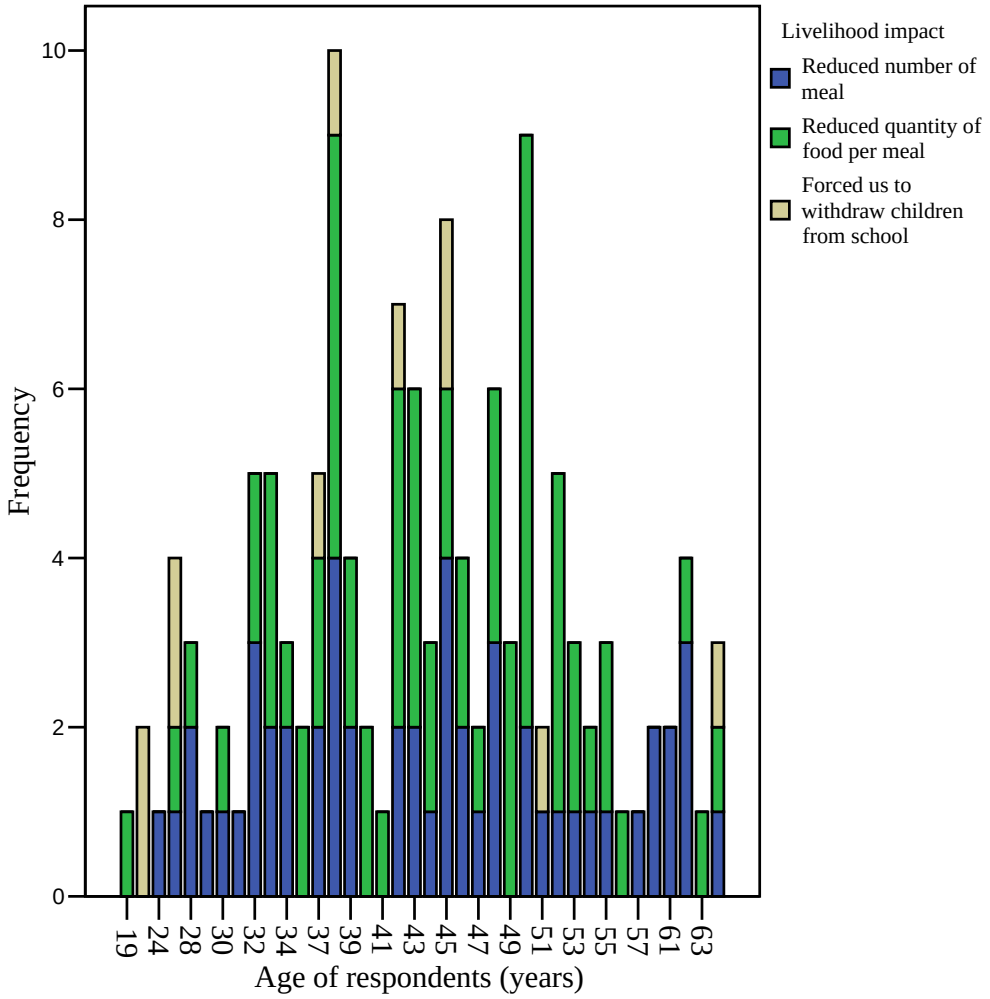

Figure 7: Age of respondents and their responses to the impact of deforestation on their livelihoods

Figure 7 above indicates the effects of deforestation on the livelihoods of the households as reported by the different age groups. All the age groups indicated that reduced number of daily meals and reduced quantity of food per day were the major consequences of reduced livelihoods of farmers. Forced withdrawal of children from school was also another problem reported by households. A negative impact of deforestation was reported by Culas (2006:429) is that deforestation reduces economic activity and threatens the livelihood and cultural integrity of forest-dependent people at local level.

Table 3 lists the number of family members per household interviewed. The member ranged from 1 to 14. The percentage of households with family members of 5 was 17%;

the percentage of households with a total family size of 7 was 15.6% and 12.8% of households had a total family size of 4.

Table 3: Family size of respondents

Family size	Frequency	percentage
1	1	.7
2	2	1.4
3	6	4.3
4	18	12.8
5	24	17.0
6	17	12.1
7	22	15.6
8	12	8.5
9	12	8.5
10	7	5.0
11	8	5.7
12	6	4.3
13	2	1.4
14	1	.7

Figure 8 below indicates the land holding size of the households, which ranged from 0.25 ha to 4 ha. When compared to the average land holding size of 2 ha at national level, only 38% of the interviewed households own land equal to the national average of 2 ha.

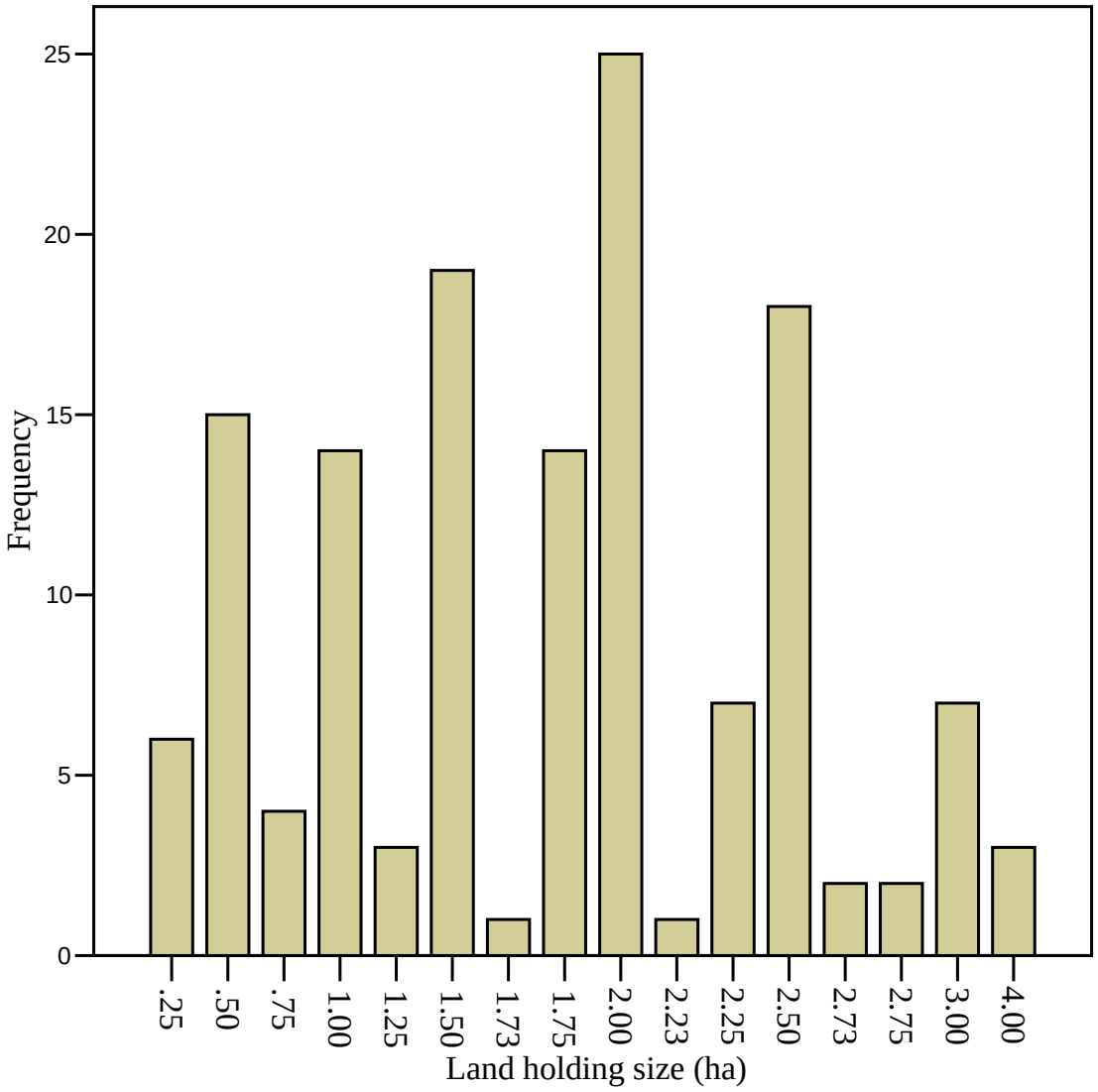

Figure 8: Land holding size in hectares

Figure 8 above indicates land holding size of households. This ranges from 0.25 a minimum to 4 ha maximum. Owning land by the households enables generation of information in relation with the impact of soil erosion and deforestation. This is because households can clearly see what erosion cause on their farm plots and the associated problem in affecting land productivity.

Table 4 below indicates that 56% of the interviewed households could read and write with 26.2% having educational levels from grades 1 to 4. The number of households with

grades 5 to 8 was 5%; and the lowest number of households was with that educational level of grade 9, which was (0.7%).

Table 4: Educational level of households

Level	Frequency	Percentage
Read and write	79	56.0
Grade 1-4	37	26.2
Grade 5-8	7	5.0
Grade >= 9	1	.7

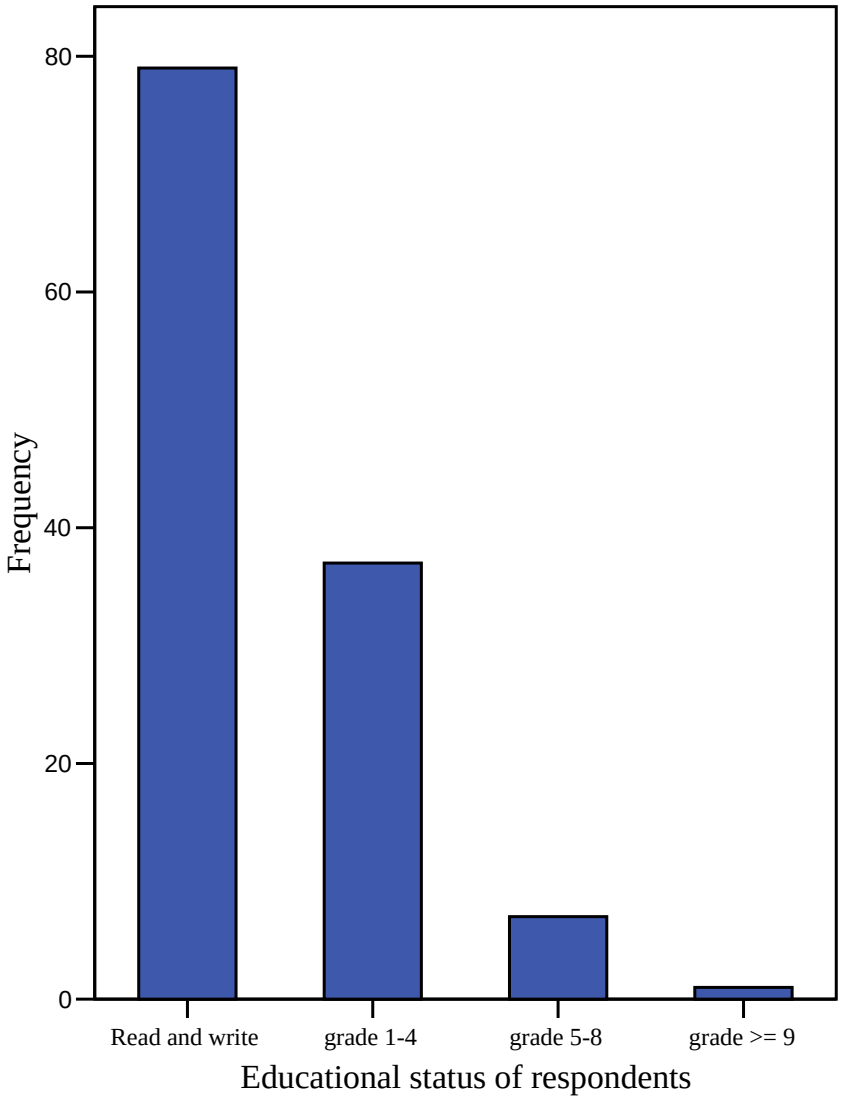

Figure 9: Educational level and knowledge of soil erosion (education and knowledge of soil erosion

As indicated in figure 9 above, all respondents has the knowledge of soil erosion regardless of level of education. This indicates that soil erosion is a well-recognized problem with in the area.

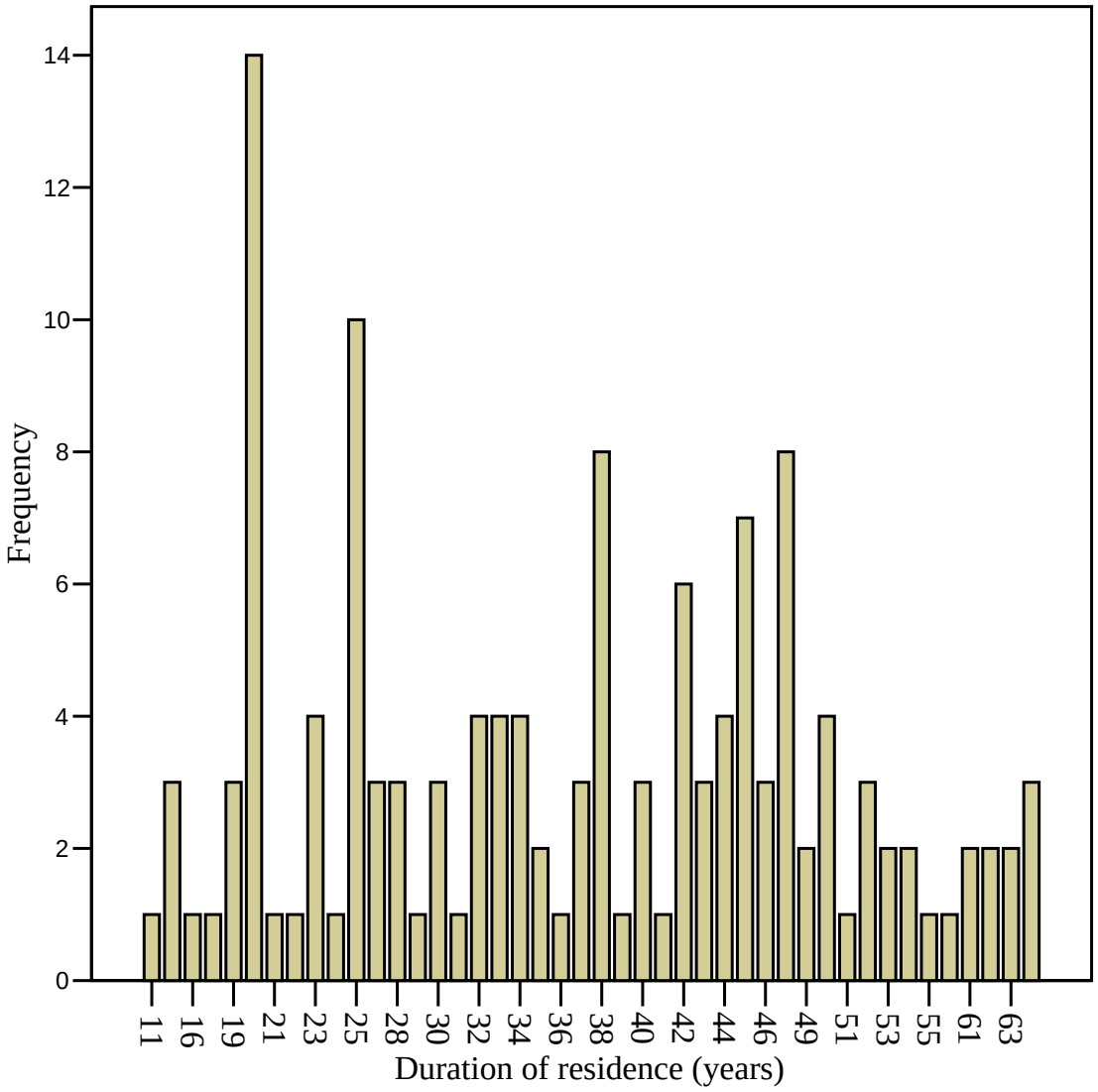

Figure 10: Number of years resident in the area

As indicated in figure 10 above, the number of years lived in the study area by the respondents ranged from 11 to 65 years; with differing numbers of years lived in the area. All of the respondents indicated that they had experienced environmental changes such as soil erosion and deforestation in the area, irrespective of the number of years they had resided there. Even respondents with the least number of years (11) living in the area recognized that there had been environmental changes, gaining an indication of serious land degradation in the area

4.3. Livelihood assets

The major components of livelihood assets of households in the area include land, cattle, small ruminants such as sheep and goats, and equines such as mules and horses. Livestock ownership also varies among the households. Of all the livelihood assets ownership of livestock is a major indicator of wealth in the area and households feel secure depending on quantity of livestock and size of land owned because livestock and land ownership form the basis of their livelihoods. Land holding ranged from 0.25 ha to 4 hectares. For instance, during food shortages as a result of a decline in production, households sell some of the livestock or lease out part of their land to buy food. Ownership of oxen has eased land cultivation as the major source of power for sloughing land. Households who do not own oxen make an agreement with households who own oxen in exchange for labor. Some of the households traditionally lease out their land as a result of having no oxen for land cultivation.

4.4. Livelihood strategies

Crop production in combination with animal husbandry is the dominant livelihood activities of the households in the area. Land holding size and the number of livestock owned by households determine the income that a household can earn. Additional livelihood sources, such as small trading, wage for labor support activities such as crop production and animal husbandry during bad seasons (owing to rainfall shortage). Cutting trees to market and producing charcoal are other activities, particularly for households with a small land holding with no or only a small quantity of livestock.

4.4.1. Crop production

The livelihoods of the households in the area, as in any rural areas of the country, are dependent mainly on land cultivation. The amount of land is the major determinant for the livelihoods of the farmers with in the area, for this determines the quantity of food

available for the households. The major crops grown in the area are tee, haricot beans, and maize. Maize is predominantly produced for household consumption while tef and haricot beans are sold

Table 5: Major livelihoods

Livelihood type	**Frequency**	**Percentage**
Farming alone	26	18.4
Farming and livestock rearing	105	74.5
All	10	7.1
Total	141	100

As shown in table 5 above, the dominant livelihood of the area is derived from farming and livestock rearing (74.5%), with 18.4% doing farming only. Farming and animal husbandry dominate because livestock are the assets that a rural household needs to possess for security in overcoming food shortages in times of crop failure. Additionally, land cultivation is undertaken using oxen and a household, unless it is very poor, needs to have at least two oxen for sloughing the land he/she owns. Based on this, the 18.45 % of households interviewed fall in to the category of poor households. The 7.15% of households interviewed indicated that earning livelihood includes small trading in addition to farming and animal husbandry.

Table 6: Perception in production change, type and reasons for change

Change over past 20 yrs	Frequency	Percentage
Yes	107	75.9
No	32	22.7

Type of change in productivity	Frequency	Percentage
Decline	58	41.1
Increase	6	4.3
Fluctuation	54	38.3
Total	118	83.7
Reason for decline in production	**Frequency**	**Percentage**
Loss in soil fertility	2	0.7
Soil erosion	17	12.1
Both	121	85.8

Table 6 above indicates the perception of households in areas of change of land productivity, type of changes and drivers of the changes observed. In this regard, 75.9% of the interviewed households have observed changes (decline) in land productivity over the last 20 years, with 22.7% having not observed any changes. In relation to the type of change in production, 41.15% of the households indicated that there had been decline in land productivity; and 38.3% of the households indicated that there is fluctuation in land productivity; and 4.3% of the households indicated that there had been an increase in land productivity.

The other important aspect is knowledge of the drivers responsible for the decline in land productivity. In this regard, 85.8% of the respondents responded that reasons for

declining land productivity were soil erosion and loss of soil fertility. This clearly indicates that decline in land productivity in negatively affects the livelihoods of farmers as their livelihood is dependent on crop production from their plot each year. The response of the households to the decline in land productivity and its causes is supported by studies by Yirga, (2007:52), who states that over the last decades, agricultural production and income growth in Ethiopia have lagged behind population growth. Concurrently, per capita food production, income and savings dropped. Cause for concern, in the highlands, soil, the basic natural resource on which the livelihoods of the majority of the population is based, has been steadily degraded. According to Mantel and Engelen (1997:9), human-induced soil degradation by water erosion is one of the most destructive and certainly the most extensive phenomenon worldwide, and is fast being recognized as a key issue in threatening global food security.

Table 7: Use of chemical fertilizers over the last 20 years

Fertilizer use	**Frequency**	**Percentage**
Yes	138	97.9
No	1	0.7

Time of use	**Frequency**	**Percentage**
Over the last five years	10	7.1
Over the last ten years	14	9.9
Over the last fifteen years	32	22.7
More than 20 years ago	85	60.3

One of the important issues in rural areas where land cultivation dominates livelihood activities is loss of soil fertility or loss of organic matter, with the resultant additional investment in agricultural production, one of which is in the chemical fertilizers. Beyond

posing a challenge to farmers who need to cover the costs of chemical fertilizers each year, change in chemical properties of soil is another negative effect of applying chemical fertilizers. Specific to the area, as indicated in Table 7, 97.9% of the respondents use chemical fertilizers for agricultural production. Significantly, 60.3% of the respondents have been using the chemical fertilizers for more than 20 years. This is an indication that the level of land degradation is very severe in the area and the actions that have been taken to combat soil erosion and restore soil fertility are ineffectual.

Table 8: Increase in quantity of chemical fertilizers used, reason for change and change in farm income.

Increase	**Frequency**	**Percentage**
Yes	131	92.9
No	4	2.8

Reason	**Frequency**	**Percentage**
Shortage of cultivated land	30	21.3
Lack of draught animals	40	28.4
Soil erosion	66	46.8

Increase in farm income	**Frequency**	**Percentage**
Yes	137	97.2
No	2	1.4

Table 8 above indicates the increase in the quantity of chemical fertilizers used, reasons for increase and increase in farm income as a result of using chemical fertilizers. In this regard, 92.9% of the respondents indicated that there had been increase in the quantity of chemical fertilizers used. This is a clear indicator that the level of soil fertility has been

deteriorating over time and farmers have had to make additional investment in the same plot of land that they have been cultivating over centuries.

This is one of the reasons for the increase in cost of agricultural production and the unreliability of the sector. Furthermore, 46.8% of the respondents indicated that the reason for increasing the quantity of chemical fertilizers was soil erosion. On the other hand, 28.4% and 23.3% of the respondents indicated that the reason for an increase in the quantity of chemical fertilizers used over time was lack of draught animals and a shortage of cultivated land, respectively. Regarding increase in quantity of application of chemical fertilizer, 92.2% of the households indicated that there is an increase in the quantity of chemical fertilizers used and 97.2% of households indicated that there was an increase in farm income as a result of the application of chemical fertilizers. The increase in farm income, however, was due to additional farm investment for the same plot of land.

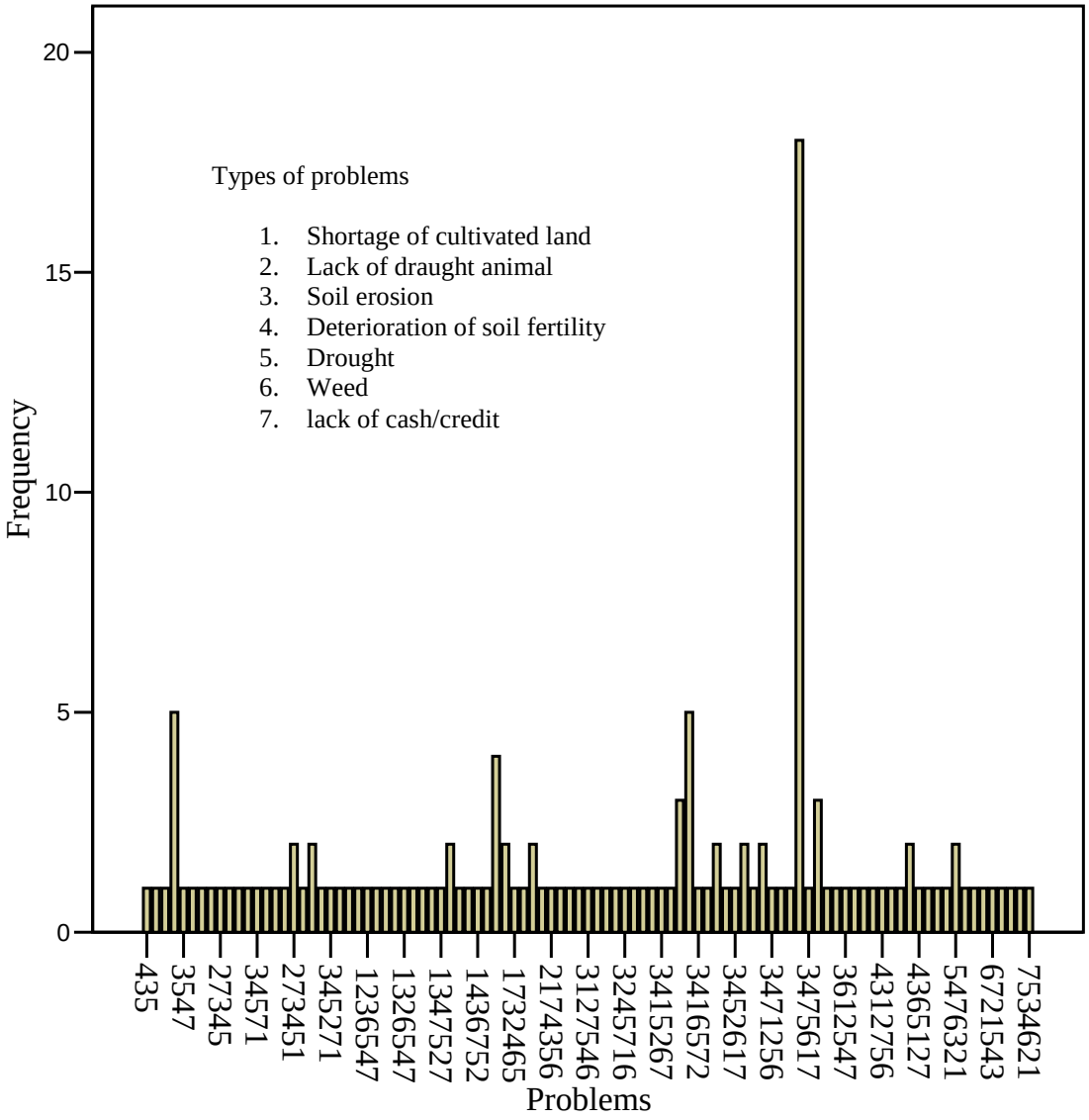

Figure 11: Problem of crop production (Ranked in order of importance)

From the range of factors that affected crop production negatively, factors 3 and 1 were ranked by the households in order of importance frequently. These were soil erosion and a shortage of cultivated land. For instance, category 3612547 shows in descending order: soil erosion, weeds, a shortage of cultivated land, a lack of draught animals, drought and deterioration of soil fertility and a lack of cash/credit. Similarly 1753426 indicated: a shortage of cultivated land, a lack of cash/credit, drought, soil erosion, deterioration of soil fertility, a lack of draught animal and weeds.

Figure 11 above indicates the range of negative factors that affect crop production and how the respondents ranked them in order of importance. Soil erosion in the area is a critical problem that has altered soil fertility and land productivity. Opportunities for the younger generation seeking employment have not been encouraging and therefore absorbing the young generation in to farming is the only option available and this in turn increases pressure on the land. Pressure on the land cased land fragmentation causing further land degradation and loss in productivity.

Studies conducted elsewhere by the NRCS (2006) and Sanahoun, Hedhues and Deybe; (2001:1) report that soil erosion usually further reduces soil quality. A soil of poor quality is less able to withstand further erosion, thus creating a further downward spiral of soil degradation. Organic matter and clay particles which have nutrients and pesticides attached may be lost with consequent reduction in fertility and crop productivity, biological activity, aggregation and rooting depth. The results of their studies support this research finding.

4.4.2. Livestock ownership

There are different levels in numbers of livestock owned by farmers in the study area. The major categories of livestock include cattle, small ruminants such as goats and sheep and equines such as mules and horses. For this particular case study, the number of cows, oxen, goats and donkeys owned were considered. Changes in animals and type of change (increase, decrease) were observed to decide how the number of livestock owned had been on the decline as a result of soil erosion and deforestation. Though there are other factors that affect livestock owned, such as lack of veterinary services and prevalence of disease in the area, the major motivation for the study was to understand how soil erosion and deforestation, and land degradation in general, affected the numbers of livestock owned in the study area

Table 9: Number of oxen and cows owned

Number of oxen owned	Frequency	Percentage
0	15	10.6
1	27	19.1
2	55	39.0
3	15	10.6
4	23	16.3
5	1	.7
6	4	2.8
7	1	0.7

Number of cows owned	Frequency	Percentage
0	28	19.9
1	56	39.7
2	32	22.7
3	18	12.8
4	4	2.8
6	1	0.7

The number of oxen owned is one of the determinants of agricultural production in the designated area and in all parts of rural Ethiopia. Oxen provide the major source of power for land cultivation. Table 9 above indicates ownership of both oxen and cows.

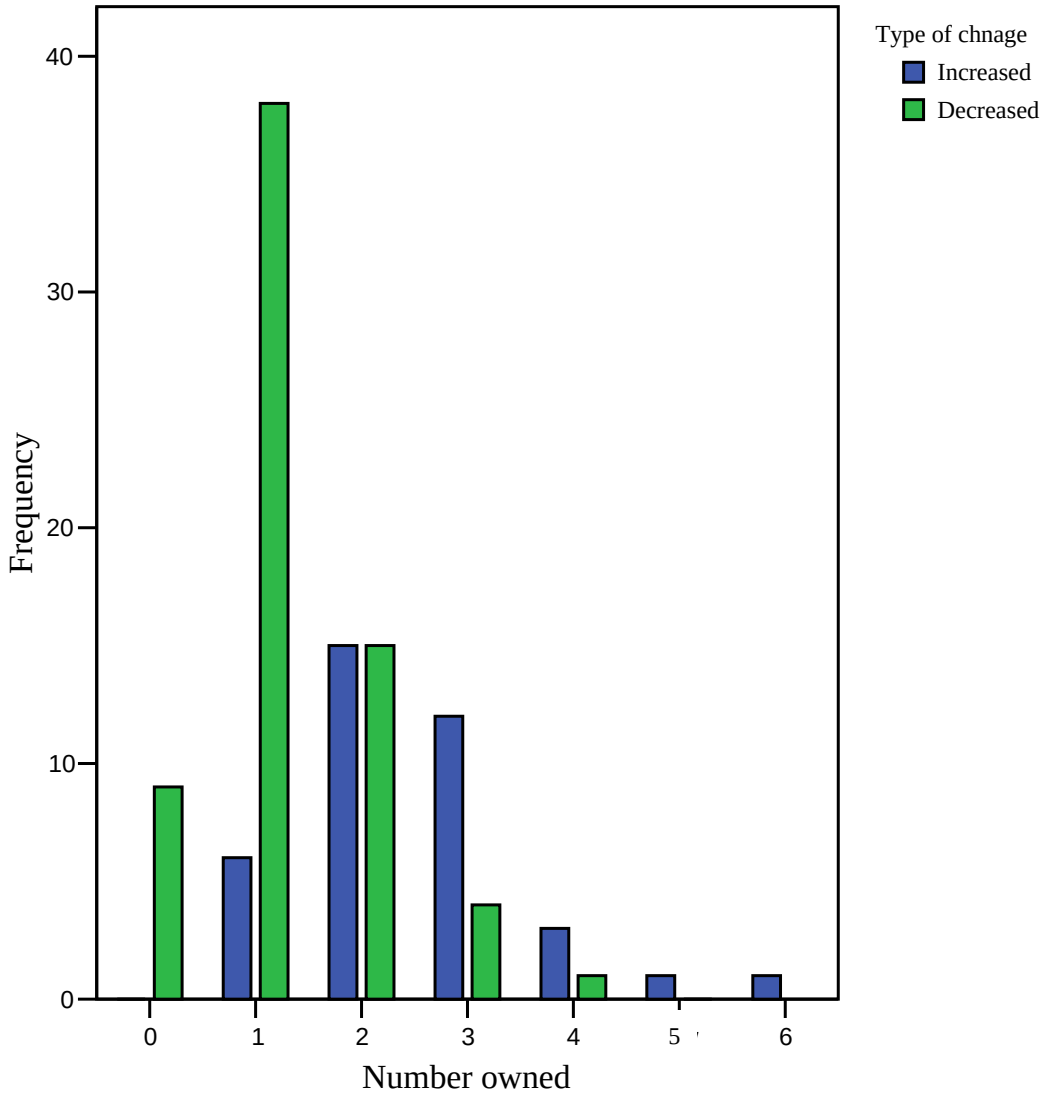

Figure 12: Number of cows owned and changes in number owned through time

Figure 12 above indicates the number of cows owned by the respondents and changes in numbers over time. The number of cows has been declining for the majority of the respondents (households who own from zero to four cows) as a result of land degradation, but for households who own five and six cows, there has been an increase in numbers as a result of improved management practices such as stall-feeding.

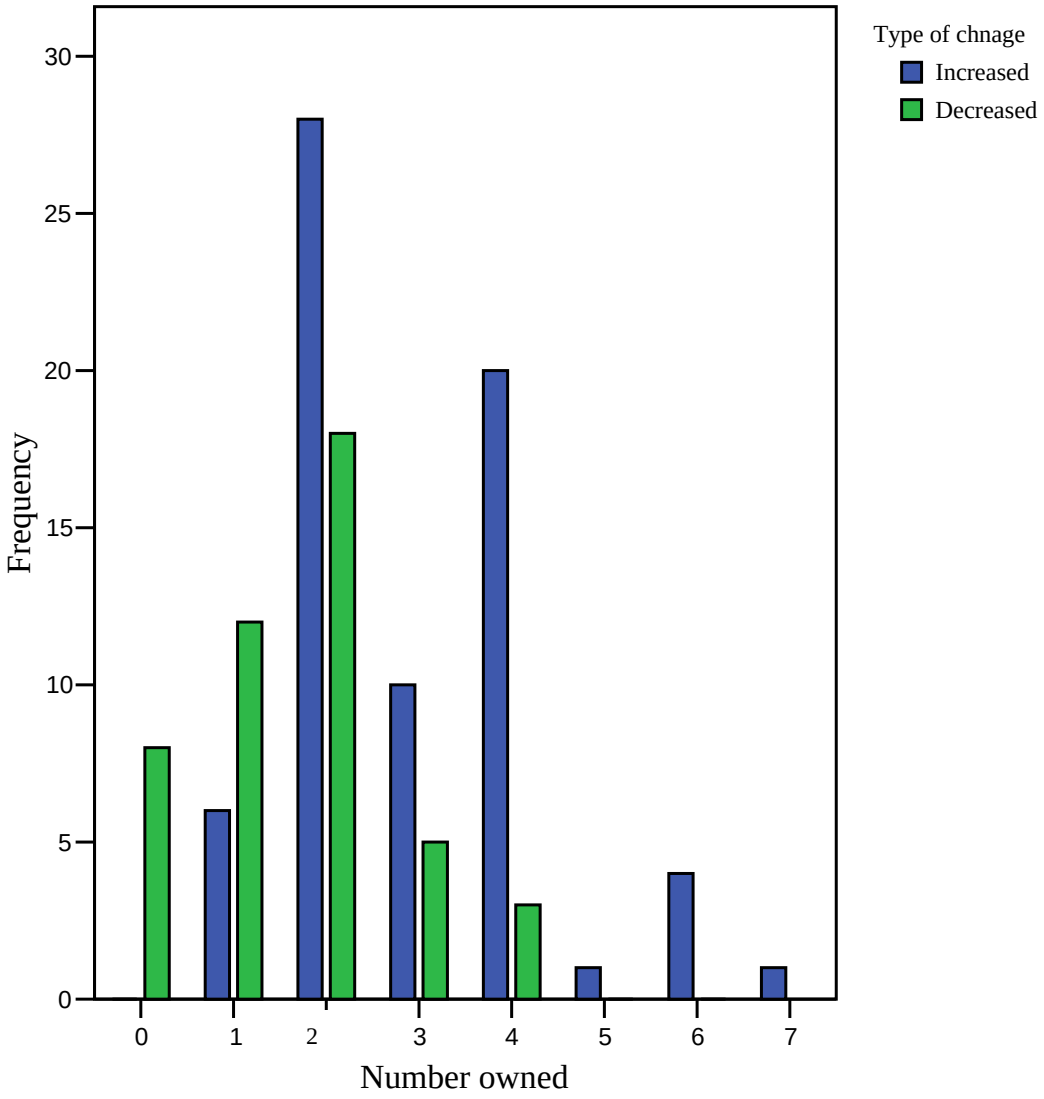

Figure 13: Number of oxen owned and changes in numbers owned through time

Figure 13 above indicates that the number of oxen owned by each household ranged from 0 to 7. For households who currently own no oxen, there has been a total loss of numbers; for households who own 1-4 oxen, there has been both an increase and a decrease in numbers. On the other hand, in households who own 5-7 oxen there has been an increase in numbers. Decrease in numbers is associated with land degradation which has been a problem to the majority of the households. For the few households that indicated that there had been an increase in numbers, the change was associated with improved management practices such as feeding.

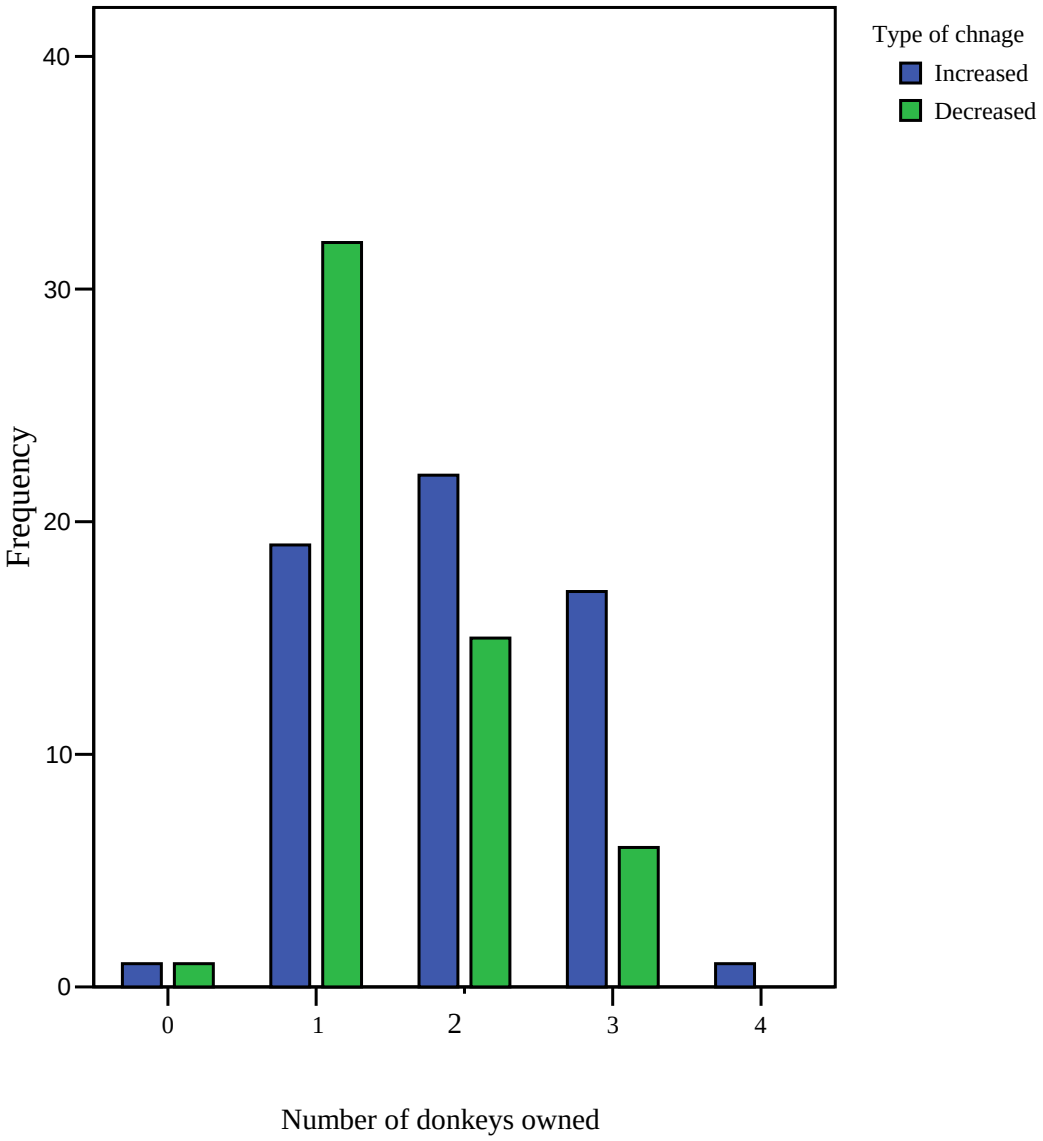

Figure 14: Number of donkeys owned and changes in number owned

A decrease in number of donkeys is associated with the land degradation resulting in a lack of pasture as indicated in Figure 14 above. The increase in a number of donkeys owned is associated with improved management practices such as feeding the donkeys factory (flour mill) by-products.

4.4.3. Problems related to rearing of livestock

Figure 15 below indicates the response of households to livestock production. Respondents ranked the problems in order of importance. From the combination of problems, the most frequently first ranked problem was shortage of feed followed by poor productivity of local breeds and thirdly lack of cash/credits. However, soil erosion was identified as a major problem by significant number of households. A shortage of feed is associated with land degradation and expansion of agricultural land which had encroached much of the grazing areas (serious land use change). In the area, there is no grazing land for livestock, as observed by the researcher during field observation, and this is a serious problem associated with land degradation. The role of land degradation in affecting crop and livestock production was also reported by other researchers. For instance, land degradation, low productivity, poverty, and declining human welfare as the dominant problems encountered in crop livestock production systems prevalent in most parts of the tropical highlands of the world (Okuma, Russel, Jabbar, Colman, Mohammed, & Pender, 1995:3)

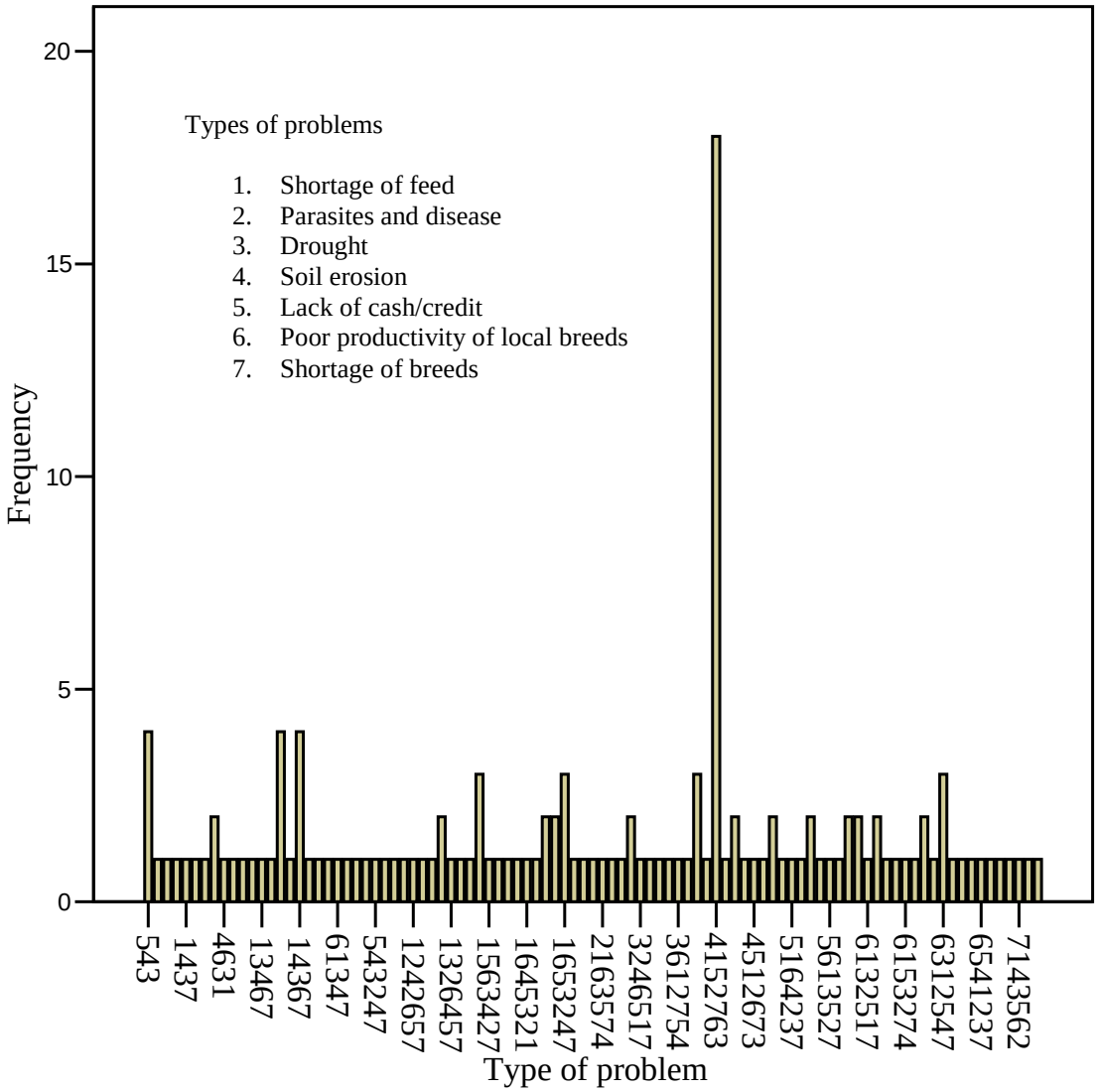

Figure 15: Problems of livestock production (Ranked according to importance)

4.5. Respondents' perceptions of soil erosion

4.5.1. Knowledge of soil erosion

The sampled households were asked to describe whether or not they were aware of the existence of soil erosion and causes of soil erosion. Irrespective of their gender, age and educational level, all the respondents had their own perception of the extent of land degradation, such as the formation of gullies and land dissection as a result of soil erosion

and the associated financial implications on their livelihoods. In trying to avert the problem in future through community mobilization, such knowledge is vital.

Table 10: Knowledge of soil erosion

Knowledge of soil erosion	Frequency	Percentage
Yes	136	96.5
No	3	2.1
Total	139	98.6

Table 10 above indicates that 96.5% of the respondents have knowledge of the existence of soil erosion and with 2.1% of the households not having noticed the existence of soil erosion. Households understand problems when they face the challenges associated with soil erosion such as a decline in land productivity and an increase in chemical fertilizers that need to be applied. From the responses of the farmers, it is clear that soil erosion has affected their livelihoods.

4.5.2. Forms of soil erosion

Table 11: Forms of Erosion

Erosion forms	Frequency	Percent
Sheet and rill erosion	5	3.6
Gully erosion	8	5.7
Both	125	90.5
Total	138	99.8

Based on the responses from the interviewed households (Table 11), sheet erosion, rill erosion and gully erosion are the predominant forms of soil erosion in the study area. The number of households that identified the above mentioned soil erosion forms as the major problems were 88%. These variations in soil erosion forms are in line with what was reported by the NRCS (2006), namely that water erosion results in the formation of rills

and gullies, stream-bank cutting at the site of removal, and down-slope deposition and sedimentation of downstream channels and water bodies. (Tripathi and Singh, 1993:27) also maintained that water erosion could occur as splash, sheet, channel (gully) and stream.

4.5.3. Causes of soil erosion

Table 12: Causes of soil erosion

Causes	Frequency	Percentage
Deforestation	59	41.8
Steep slope cultivation	24	17.0
Continuous cultivation	16	11.3
Human/livestock tracks	28	19.9

Households were aware that the causes of soil erosion were: deforestation, steep-slope cultivation, continuous cultivation and human/livestock tracks, all these are related to the mismanagement of the land resources such as soil and forests. The perception of the households as to the causes of soil erosion is in line with studies conducted by others (Titilola, 2008:6; Descorois, Barios, Varmantes, Polenard, Anaya, & Esteves, 2008:327)), who report that the most frequent cause of land degradation and soil erosion stem from excessive human pressure or poor management of the land, overgrazing, over-cultivation of crop land and deforestation, are the main culprits.

What households perceive the consequences and livelihood impacts of soil erosion to be is in support of the objectives of the study therefore these are vital for programming soil conservation and reforestation activities. The development agents assigned to the area and the experts at district level are fortunate in that the households are willing to mobilize the community to tackle the problem.

4.5.4. Consequences of soil erosion

Table 13: Consequences of soil erosion

Consequences	Frequency	Percentage
Loss of crop production	41	29.1
Gully formation and land dissection	34	24.1
Loss of soil fertility	21	14.9
Damage in infrastructure	16	11.3

Table 13 above shows the responses from the households in to the effects of soil erosion. Loss in crop production was indicated by 29.1% of the households whereas 24.1% indicated that the consequence of soil erosion was gully formation and land dissection. The number of households who responded that soil erosion led to loss of soil fertility was 14.9% and the number who indicated that soil erosion damaged infrastructure was 11.3%. All the parameters indicated in the table are consequences of soil erosion though the degree of severity varies. The overall impact of soil erosion means a loss of land productivity with reduced farm income which directly affects the livelihoods of the rural population with in the area.

4.5.5. Effects of soil erosion on livelihoods

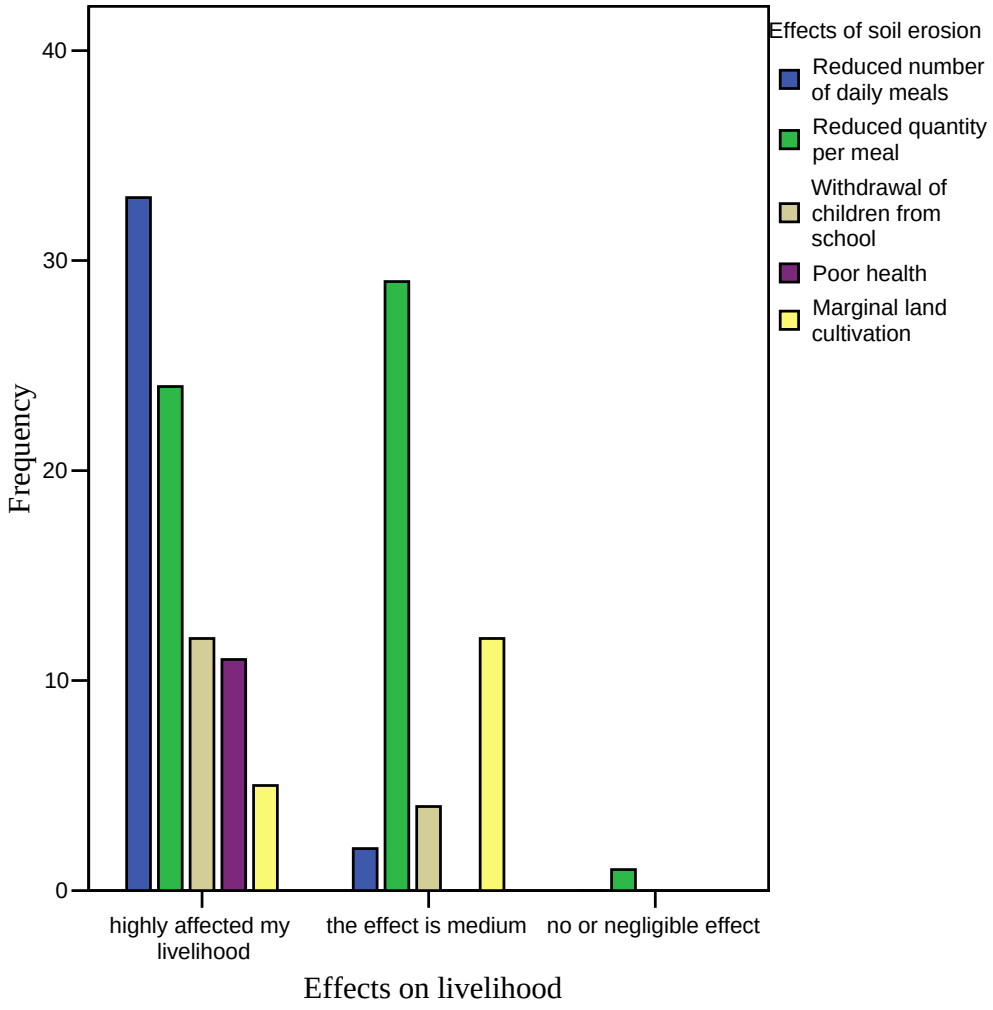

Figure 16: Effects of soil erosion on livelihoods

Figure 16 above shows the respondents' views on the effect of soil erosion on their livelihoods. The majority of the respondents reported that their livelihoods were seriously affected and copping strategies such as reduced numbers of daily meals, reduced quantity of food per meal, withdrawal of children from school and marginal land cultivation had to be adopted. The second response to the effect of soil erosion on livelihoods reported that there were noticeable effects on livelihoods. It is clear that the effects of soil erosion on livelihoods of farmers vary.

The chief impact of soil erosion, namely depletion of productive capacity of land under cultivation, is its effect on food security. Cultivating marginal land exacerbates the

problem through further altering of land forms and changing land use. Soil erosion means that households have to invest additional expenses to purchase chemical fertilizers. Withdrawing children from school exacerbates the impact of soil erosion on livelihoods of the rural population in that children who lack access to education will be dependent on the land resources available to their parents and further fragmentation of the land, thereby exacerbating land degradation.

Table 14: Effects of soil erosion on livelihoods

Livelihood impacts	**Frequency**	**Percentage**
Seriously affected my livelihood	89	63.1
The effect is noticeable	47	33.3
No or negligible effect	1	.7
Total	137	97.2
Missing system	4	2.8
Total	141	100.0

Table 14 shows the effect of soil erosion on livelihoods, with 63.1% of the respondents indicating that soil erosion has affected their livelihoods seriously, with 33.3% indicating that the effect of soil erosion on their livelihood has been noticeable.

4.6. Means of overcoming impacts of soil erosion

Whenever there are negative impacts on livelihoods of rural households such as reduction of income, several strategies need to be applied to tackle the problem. These can be either negative or constructive. One of the negative ways of temporarily overcoming the problem resulting from soil erosion is cutting down trees and making charcoal to sale (Table 15). Cutting down trees for fuel and making charcoal for sale to supplement

reduced incomes as a result of land degradation, means that the vicious cycle of poverty and food insecurity in almost all parts of the country continues.

Table 15: Strategies to overcome the effect of soil erosion on livelihood

Methods	**Frequency**	**Percentage**
Sale of productive assets such as livestock	27	19.1
Sale of forest products such as charcoal	13	9.2
Wage earned from labor	59	41.8
All	39	27.7
Total	138	97.9

Of the various strategies employed to cope with soil erosion effects on livelihoods wage labor was the most frequently used strategy as indicated by 41.8% of the respondents.

4.7. Soil conservation practices

To overcome the problem of land degradation, the government has implemented soil conservation activities, such as construction of physical structures (terraces) to reduce overland flow thereby preventing removal of soil, soil fertility improvement practices (compost application), agro-forestry and reforestation of deforested hilly areas. These practices and the positive results yielded so far show how communities can reduce land degradation and improve their livelihoods and food security. Direct observation and interviews with farmers indicated that there were some initiatives, but there was still a long way to go.

Table 16: Soil conservation practices and results

Application of conservation measures	**Frequency**	**Percentage**
Yes	130	92.2
No	6	1.4
Total	136	96.5

Observation of changes (increase in yield)	**Frequency**	**Percentage**
Yes	128	90.8
No	2	1.4
Total	132	93.6

For comparative purposes, households were also asked to report on the conservation practices they had undertaken, if any. Table 16 above summarizes the responses to questions on conservation practices, such as terracing, soil fertility improvements through the application of compost, undertaken and the results achieved. The number of the respondents who indicated that they had practiced soil conservation activities such as terracing was 92.2% with only 1.4% admitting that they had not applied any soil conservation measures.

From the fact that several soil conservation measures have been applied, it is clear that the households have a sound perception of soil erosion problems and insight into how the problem can be alleviated. With regard to the result of the conservation measures practiced, 90.8% of the respondents reported on changes such as improvement in soil fertility and increase in yield, while 1.4% of the respondents stated that they had observed no change as a result of the conservation measures being implemented.

Reforestation of degraded areas and gully protection activities such as check-dam (a physical structure constructed in gullies to reduce flow of water thereby reducing damage

to the land) construction, gully-side embankment protection and re-vegetation support restoration of land productivity. The income of farmers is increased and the problem of wood for fuel is eased. Water harvesting activities such as terraces and micro-basins support natural regeneration and wood for fuel and construction purposes.

Rain water harvesting on farm lands through construction of variety of physical structures can raise the level of moisture in the soil ensuring better crop growth and crop production. The communities have increased access to water for domestic consumption and small-scale irrigation by pond and micro-pond construction through which rain water is harvested. The small-scale irrigation scheme supports the annual-based rain-fed agriculture and enables the farmers to have additional income thereby improving their livelihood. These activities have been initiated in the study area and, if continued and all areas of the watershed are serviced equally, land productivity will be increased and the goods and services that the communities will gain from optimal use of the natural ecosystem will be enhanced.

4.8. Sources of energy for cooking

As in any rural areas of Ethiopia, the source of energy in the study area is largely biomass energy, particularly trees. Fuel wood is used as fuel for both cooking and lighting. Consequently vast numbers of trees are cut each year, adding significantly to the rate of deforestation. Physical collection of wood, which is the responsibility of women and children as in the case in Ethiopian rural areas, is one of the factors affecting livelihoods negatively.

Table 17: Source of energy

Source of energy	Frequency	Percentage
Wood	119	84.4
Kerosene/charcoal	19	13.5
Total	138	97.9

The above table 17 indicates the sources of energy used by households in the study area. The respondents agreed that the major source of energy for cooking was wood. In this regard, 84.4% of the respondents indicated that the source of energy was wood, with 13.5% using additional sources of energy such as kerosene and charcoal. A previous study conducted by Bekele (2001:10) reports that the energy sector in Ethiopia remains heavily dependent on wood for fuel. Wood provides 78 %, with dung and crop residues supplying 16 % of the energy required. Asfaw (2003:11) reports that a marked feature of Ethiopia's energy sector is the high proportion of biomass consumed (about 93 %) when compared to modern forms of energy consumption. Other researchers support the findings of this study that deforestation and land degradation are the most serious problems in rural Ethiopia, where the majority of the population is dependent on the forest products as a source of energy.

Table 18: Responsibility to collect wood for fuel

Responsibility	Frequency	Percentage
Men	2	1.4
Women	36	27.5
Children	18	12.8
Men, Women and children	74	52.5

Table 18 above indicates which member bear the responsibility for collection of wood for fuel, with 27.5% of the respondents indicating that collection of wood was the responsibility of women while 12.8% of the respondents indicated that the responsibility was shouldered by children. Only 1.4% indicated that men collected wood. On the other hand 52.5% of the respondents indicated that the responsibility for collection of wood rested on women, men and children. This indicates clearly that deforestation affects women and children because an increasing amount of time is spent on collection of wood.

It is a major burden, particularly on the women, as they are the members of the community who have to manage the households. Similarly, available time for schooling of children is reduced significantly. The problem of deforestation imposes an additional burden on women as is reported by Ayanwuyi, Oladosu, Ogunlade and Kuponiyi, (2007:474). The workload of women is increased as they need to travel further to seek fodder, water and fuel, resulting in less time for income generation and other activities to improve their standard of living.

Table 19: Alternative sources of energy

Alternatives	Frequency	Percentage
Cow dung	29	24.6
Crop residue	6	4.3
Cow dung and crop residues	12	8.5

In Table 19 above alternative energy sources for cooking such as cow dung and crop residues, are listed with 24.6% of the households using cow dung and 4.3% using crop residues.

Table 20: Time spent on collection of wood for wood

Time spent in hours	Frequency	Percentage
1	1	0.7
1.5	29	20.6
2	24	17.0
3	38	27.0
4	21	14.9
5	15	10.6
6	8	5.7
7	2	1.4

Table 20 above indicates time spent on collection of wood for fuel for households which ranges from 1 to 7 hours. This is significant in terms of economic interpretation because if this time were to be used for other household activities, increased income could have been generated for their households. The majority of the respondents (27%) report that they spend 3 hours on collection of fuel wood. An average time of 4 hours, is reported by 14.9% of the respondents, consequently, deforestation increases the time spent on collection of fuel wood with resultant reduction in income for households.

Table 21: Increase in time spent on collection of wood for fuel over the last 20 years

Increase in time spent	**Frequency**	**Percentage**
Yes	94	66.0
No	41	29.1
Total	135	95.7

Reasons for change in time	**Frequency**	**Percentage**
Reduced availability of wood for fuel\	84	59.6
Expansion of protected areas	34	24.1

Table 21 indicates that the time spent on collection of wood has increased steadily as a result of deforestation. This has reduced productive time of households considerably. From the respondents' point of view, for increase in time spent on the collection of wood for fuel, the problem of deforestation is serious and continues to affect their livelihoods significantly.

4.9. Observation of change in vegetation

Understanding the changes in environmental conditions stems mainly from knowledge of and insight into the changes related to the availability of natural resources, particularly soil, forest and water. With declining forest cover, environmental and economic costs increase each year therefore the next generation will face severe challenges unless the current generation implements strategies to reverse deforestation, through planting tree seedlings and managing the existing vegetation significantly.

Table 22: Observation of decline in vegetation

Observation of vegetation change	Frequency	Percentage
Yes	136	96.5
No	0	0

Observation on vegetation change as a result of deforestation was one of the points used to collect information from the sampled households. Table 22 above summarizes the response from sampled households, with 96.5% of the respondents indicating that there is a change, such as a decline in vegetation cover. No household failed to notice change in vegetation; regardless of age categories.

Table 23: Observation of deforestation

Observation of the existence of deforestation	Frequency	Percentage
Yes	136	96..5
No	0	0

Observation of vegetation change (a general term for all green plants) and deforestation are similar since deforestation has led to a decline in vegetation cover over the past 20 years. Households were also asked whether or not they had observed deforestation in

their area. As in Table 23 above, 96.5% of the respondents indicate that they have observed deforestation in their areas. No respondent failed to recognize the existence of deforestation within their areas regardless of age. This is similar to the observation of vegetation change. Therefore, it is clear from the responses of the households sampled that deforestation is clearly understood by the community in the study area.

Table 24: Causes of deforestation

Causes	Frequency	Percentage
Search for wood for fuel	51	36.2
Search for construction wood	14	9.9
Charcoal	35	24.8
Illegal logging for sale	22	15.6
Expansion of agricultural land	9	6.4

Based on Table 24 above, the majority of the respondents (36.2%) report that one of the causes of deforestation is the increasing search for fuel, with 24.8% of the respondents indicating that making charcoal is another cause of deforestation. Charcoal generates income, particularly when agricultural production declines as a result of failure or reduction in annual rainfall. The third major cause of deforestation indicated by 15.6% of the respondents, is illegal logging with 9.9% and 6.4% of the respondents indicated that the search for construction wood and expansion of agricultural land are additional causes of deforestation.

Table 25: Effects of deforestation on livelihoods

Effects on livelihoods	Frequency	Percentage
Reduced number of meal	54	38.3
Reduced quantity of food per meal	65	46.1
Forced to withdraw children from school	11	7.8

Deforestation has negative effects on livelihoods as shown in Table 25 above. Coping strategies of 46.1% of the respondents include reducing the quantity of food per meal per day, with 38.3 % reporting that they are forced to reduce the number of meals taken per day, and 7.8% of the respondents forced to withdraw their children from school since they cannot provide them with food. The negative effect of deforestation on livelihoods of rural households is also reported elsewhere, Sunderline *et al.* (2005:1384) maintain that the dwindling natural forests in developing countries is a critical problem, since this negatively affects the livelihoods of people dependent on forest products and services.

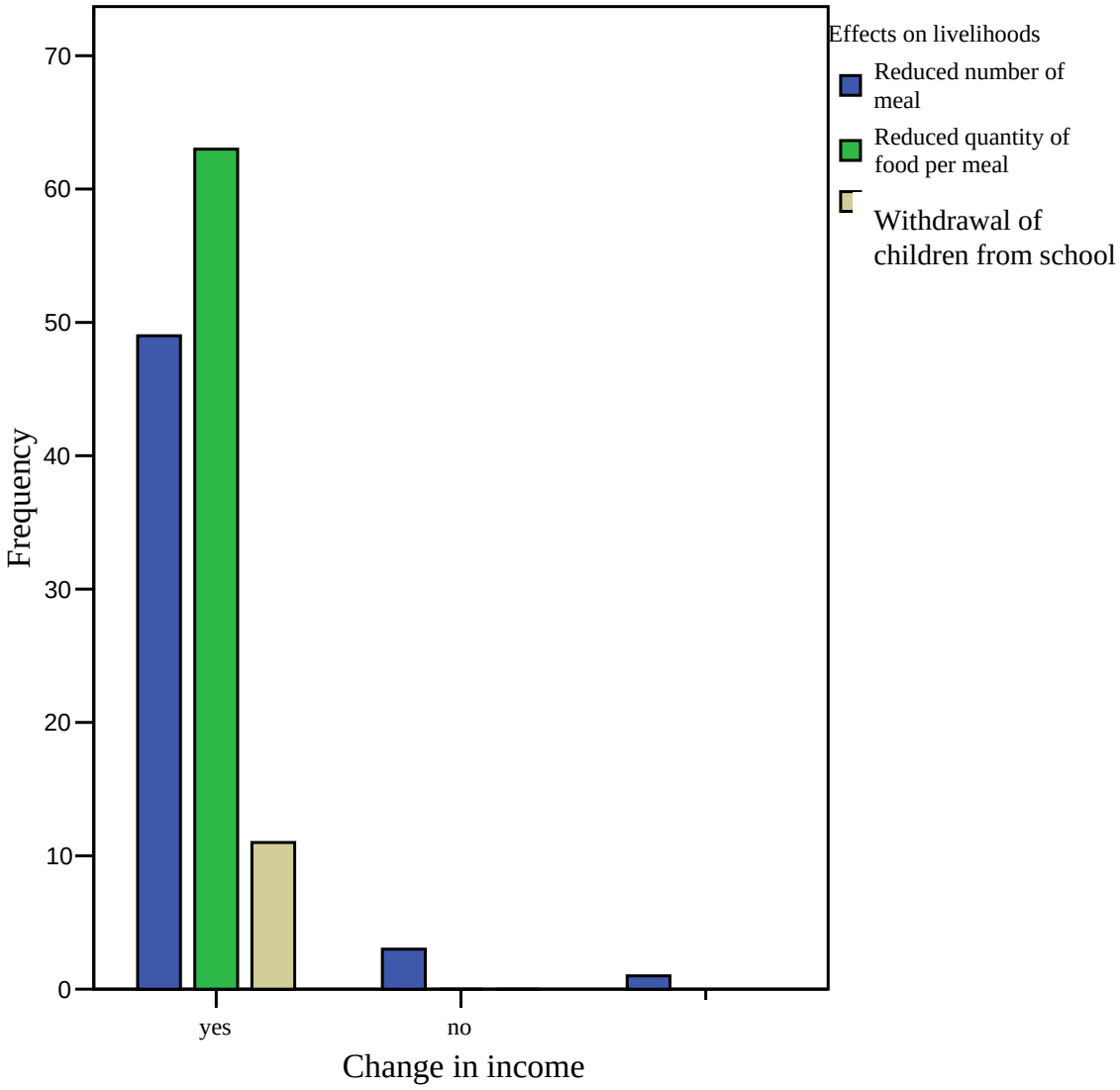

Figure 17: Income and livelihood impact of Deforestation

Figure 17 above supports the facts reflected in table 24 on the negative impact of deforestation on income of households in the study area. The majority of the respondents indicate that the reduction in income had resulted in adopting strategies such as reducing the quantity of food taken per meal, reducing the number of meals taken per day and withdrawal of children from school. Very few respondents (0.05%) answered "No" to the statement on reduction in the number of meals taken per day.

4.10. Livelihood trends

Crops such as cereals are a major source of food and marketing for households. Income generated from marketing crops is source of cash to cover other household expenses such as clothing, school fees for children and costs of fertilizers. An analysis of the trends in crop production, both for household consumption and for sale, reinforces the findings on the effect of land degradation on the livelihoods of the households in the study area.

Table 26: Trends in crop production for sale and for consumption

Crop production for consumption	**Frequency**	**Percent**
Improving	27	19.1
Worsening	45	31.9
Stable	11	7.8
Fluctuating	51	36.2
Don't know	1	0.7

Crop production for sale	**Frequency**	**Percent**
Improving	47	33.3
Worsening	45	31.9
Stable	9	6.4
Fluctuating	36	25.5
Don't know	3	2.1

Household asset protection	**Frequency**	**Percent**
Improving	10	7.1
Worsening	28	19.9

Stable	28	19.9
Fluctuating	65	46.1
Don't know	7	5.0

Food security (food availability)	**Frequency**	**Percent**
Improving	17	12.1
Worsening	44	31.2
Stable	16	11.3
Fluctuating	58	41.1
Don't know	3	2.1

Trends in crop production both for consumption and sale, asset protection and general food security situation were also assessed through interviews with household members as indicated in Table 26 above. From the responses of the households, the general impression of the overall food security is that the situation is not stable. This has resulted from decline in agricultural production as a result of severe soil erosion. The finding of this study on the negative impact of soil erosion on food security has also been reported in previous studies. Stocking (2003:1), Scher and Yadav as quoted by Abegunde, Adynk and Olawuni (2006:2), confirm that erosion-induced loss in soil productivity is one of the major threats to global food and economic security, especially for poor farmers. Erosion not only diminishes the quality of soil resources but also renders earning a sustainable livelihood from the land increasingly difficult. Reducing productivity of soil, affects outputs such as crop yields that is derived from the renewable nutrient system of the biosphere.

4.11. Key informant interviews and focus group discussions

Key informant interviews with the planning team (a team with ten members comprising 50% from both genders who are in charge of managing community level development activities), indicated that both soil erosion and deforestation were major causes of land

degradation in their community. In relation to change in environmental conditions, they confirmed that they had observed changes such as a decrease in vegetation cover, with a decline in soil fertility as a result of soil erosion.

They linked changes in the environment such increases in daily temperature, and decreasing rainfall and the erratic nature of rainfall, to a decline in availability of trees. Formerly, household used to have adequate numbers of livestock as there was good grazing. Currently some own no livestock or very small when compared with the previous years. In general, the situation they find themselves in now, when compared to the time when most of them were young, has deteriorated. Now it is very difficult to make a living because there are a whole range of new problems including serious reduction in soil fertility and frequent crop failure. Collecting water for drinking presents a further challenge and they are forced to travel long distances to get wood for fuel.

The major reasons for change in the environment according to these informants were soil erosion, deforestation, expansion of agricultural land, and a shortage of rainfall. They also indicated that an increasing number of people experience poverty as a result of deteriorating livelihoods systems of their community. This is mainly due to erratic agricultural production and/or loss in land productivity. There is no wood for fuel, no water to drink and less wood for construction, forcing them to use mud-bricks to construct their houses. The general perception of the planning team was that both soil erosion and deforestation affected the livelihoods of farmers significantly. These views and knowledge are in line with what has been discussed by the household members who were interviewed.

The expert level focus group comprised a district level soil and water conservation expert, an animal husbandry expert and an agronomist. The three development agents are professionals in the field of agronomy, natural resource management and animal husbandry. The focus group discussion at expert and development agent level indicated that land degradation, which is associated with soil erosion and deforestation, is the major

problem of their district in general and the study area in particular as it is located entirely within the rift valley which is characterized by a very fragile ecosystem.

According to these experts, soil erosion reduces and ultimately depletes soil fertility resulting in failure in crop production, damaged land and ultimately land with no productive potential. Soil erosion also reduces soil fertility of pasture land negatively affecting livestock production this presents a major challenge in the district and in the study area. Deforestation affects hydrological cycles, as the contribution of forests in cycling water through evapo-transpiration is reduced. These changes lead to reduction in annual rainfall as erratic patterns resulting in frequent failure of crops that affects livelihoods of the households in the area. Both soil erosion and deforestation deplete moisture in the soil and affect biomass production by altering the cycle of nutrients.

According to the key informants, deforestation also results in loss of wild life, by seriously reducing biodiversity. This presents a major challenge to be keeping, which was traditionally one of the major sources of income. According to the experts and development agents, soil erosion and deforestation are the major problems that seriously affect the livelihoods of the communities in the district, in general and in the study area, in particular.

4.12. Summary of the results

From all of the interviews, discussion, field observation and consultation with the experts it was found that both soil erosion and deforestation as a form of land degradation are widespread phenomena in the study area that negatively affected the livelihoods of the community members. Deforestation is another major problem of the community in the study area. The community members are forced to travel long distances to collect wood for fuel and much of their time is taken up collecting wood. This could have been used productively to increase their income and their livelihoods. Environmental degradation as a result of both soil erosion and deforestation has reduced the goods and services that the community had access thereby negatively affecting their standard of living.

As a result of the degradation of soil, the community in the study area has been to increase farming expenses since the quantity of chemical fertilizers being applied has had to increase. Responses from the respondents indicate that the cost of chemical fertilizers is rising. From the general trends in crop production, livestock rearing, and food security situation, there is a clear indication that the community members are facing critical problems. Their livelihoods are dependent on adequate and reliable rain, which at present is not the case as a result of sustained drought. In general, the overall results from both interviews the interviews with the sampled households and discussions with key informants reinforce the fact that the livelihoods of the community are being threatened by land degradation, the drivers of which are soil erosion and deforestation.

Chapter 5

Conclusions and Recommendations

5.1. Conclusions

Soil erosion and deforestation are serious problems that negatively affect livelihoods of farmers in Ethiopia. Members of households, selected through simple random sampling were interviewed. A diverse sample ranging in age from 19 to 65 years was identified. Perceptions of the effects of soil erosion and deforestation were identical, regardless of the age groups of the participants. Land holding size of the respondents ranged from 0.25 to 4 ha and the number of members per family ranged from 1 to 14. Livestock owned varied from 0 to 5 for cows and 0 to 7 for oxen. Both gender groups were included in the sample, with 17.7% being women and 82.3% being men

The major livelihood earners according to household members are farming and livestock rearing, with a very few respondents indicating that they are also engaged in small trading. When asked about observation of change in land productivity, the majority of the respondents indicated that they had observed changes (decline) in production (75%) and a significant reduction in production over time. Chemical fertilizers have been used over

the last 20 years with an increase in the quantity used over time as a result of decline in soil fertility.

Both soil erosion and deforestation are major drivers of land degradation and pose key problems to livelihoods of the community members in the study area. Sheet, rill and gully erosion are the main types of erosion with in the study area and the latter form of erosion, namely gully erosion, is the most alarming problem removing huge quantities of soil, dissecting land and damaging infrastructure.

Deterioration in soil fertility as a result of severe soil erosion is a critical deterrent to crop production and a lack of fodder has been a major factor in the decline in livestock production. As wood is the major source of energy for cooking in the study area, deforestation has seriously depleted forest resources. This has compelled community members to travel long distances and spending significant amount of time for collection of wood.

As alternative sources of energy, the community members burn cow dung and crop residues, both leading to degrading soil as the application of compost and nutrient recycling has been adversely affected exacerbating the problem of crop failure and dwindling land productivity. The negative effects of both soil erosion and deforestation on the livelihoods of farmers are well understood by the households. The existing attempts implemented to combat the problems of soil erosion and deforestation has helped when a comparison is made between a situation as it was and the results achieved so far.

The methods used in the design of the study, specifically the sampling and data collection both households and key informants, have addressed the objectives of the study. In general the results are in line with previous studies and literature. Therefore, the aim of this research has been achieved as it has been shown that both soil erosion and deforestation negatively affect livelihoods of small farmers.

Though it is tempting to generalize the results of this study from a micro-watershed to the overall conditions of Ethiopia, the fact that the work was conducted in a very small area, is limiting aspect of this study. This study has also not addressed the negative effects of land degradation on livelihood in pastoral areas as the livelihoods in such areas are quite different from livelihoods of agriculturalists. Quantification of the rate of soil erosion and deforestation was not part of this study. This study did not estimate the economic costs of both soil erosion and deforestation as this was not the point of departure. Carrying out similar assessments in all the agro-ecological zones of the country will supplement the results of this study.

5.2. Recommendations

From a clear understanding of the problem of soil erosion and deforestation, not only from the point of effects on livelihood, but also from the point of environmental sustainability and wellbeing of the ecosystem, a comprehensive program of land management interventions should be implemented to avoid further damage. This will entail mobilizing resources, experts and the community at large. It is imperative to assess the economic implications of both soil erosion and deforestation together with the costs that need to be incurred to remedy the situation. Policy makers need to be committed to making a difference and embarking on natural resource management instead of merely rehabilitating degraded lands which use up precious resources. The notion of prevention is better than cure undeniably applies.

More specifically the following points are worth recommending:

- Awareness should be created at all levels on the negative effects of land degradation on the livelihoods of farmers.
- The rate of soil erosion and deforestation should be quantified, as well as the associated costs.

- Community mobilization to improve soil fertility through the application of compost should be given due consideration to reduce the rising expenses of that farmers are incurring as a result of increasing cost of chemical fertilizers.
- Comprehensive watershed management planning for disseminating sustainable land management interventions at community level and vigorous national-level programmes should be implemented.
- Alternative technologies in soil and water conservation measures should be explored by national research institutes, tested and disseminated taking in to account on the different agro-ecological zones of the country
- Special emphasis should be placed on the evaluation the rate of survival of seedlings to bolster the existing initiatives in tree planting and reforestation.
- Community-based area closures and natural forests should be protected and managed.
- Alternative energy sources should be considered and information disseminated at grass roots level to protect the remaining forests.

Glossary of Terms

Agrarian: Agriculture dominated economy and livelihood

Agro-ecology: Division of an area based on altitude, vegetation, crop grown, soil type and rainfall

Agro ecosystem: System of agricultural production within a specified environment

Agro-forestry: System of agriculture where crops and forests are grown on a single plot of land

Biosphere: Part of the atmosphere where life exists

Biological Diversity (Biodiversity): Species richness

Biomass: Green matter like grass, forest, bush etc…

Crop land; Land under cultivation for production of crops

Crusting: Sealing of soil pores which cannot infiltrate water in to the soil

Desertification: Transformation of an area in to a desert

Dry spell: Days where there is no rain during rainy season or the time interval between each rain fall times

Ecology: Branch of Science that deals with the study of organisms and their physical environment

Ecosystem: Interaction of organisms with their physical environment

Elevation: Measurement of height of an area referencing sea level

Fauna: Animals and wild lives of a specific area

Flora: Plants (green matter) of a specific area

Fodder: Livestock feed

Food security: The availability, access, utilization and stability of food for a household

Gully: Water course that is formed as a result of severe erosion

Hydroelectric: Eclectic power generated from water

Hydrological cycle: The cycle of events for a rainfall (evaporation/Transpiration, Condensation and Precipitation)

Inert soil: Soil with very poor fertility that could not give production

Infiltration: Soaking of water down in to the soil

Land degradation: Deterioration of the potential of a specific land use system to give adequate production of crops, animal feed, forests etc…

Livelihood: Comprises the capabilities and assets (financial, social, physical, and human) and activities required to provide a means of living

Onset: Starting time of rainfall

Organic matter: Decomposed material from different green matter (biomass) which improves the fertility of soil

Recurrent: Frequent/often times

Pasture: Animal feed

Siltation: Accumulation of fine particles of soil as a result of run-off

Watershed; A geographic area that drains run-off to the same out let or confluence point

References

ABEGUNDE A., ADEYINK S., OLAWUNI P., 2006. An assessment of socioeconomic impact of Soil Erosion in Eastern Nigeria, Research Paper. Munich, Germany.

ALEMAYEHU M., YOHANES F., DUBALE P., 2006. Effects of indigenous stone bunding on crop yield at Mesobit Gendeba. *Journal of land degradation (17): 45-54.* [Online] Available from: www.interscience.Wiley.com. [Accessed: 23/9/2010].

AMSALU. A, 2006. Caring for the land: Best practices in soil and water conservation in Beressa Watershed. High lands of Ethiopia; Research Paper. Haromaya, Ethiopia.

AMEDE. T, BELACHEW. T, AND GETA. E, 2001. Reversing degradation of arable lands in Southern Ethiopia; Research Paper. Addis Ababa, Ethiopia.

ANGELSEN. A, BALCHER. B, 2005. Livelihoods, forests, and conservation in developing countries: an overview. *Journal of world development,* 33(9):1384-1402 [Online]. Available from: www.elsevier.com/locate. [Accessed: 18/09/2010].

ARGAW. M, 2005. Forest conservation, soil degradation-Farmer's perspective nexus: Implications for sustainable land-use in South west Ethiopia; research Paper. Addis Ababa, 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.

AYANWUYI E., OLADOSU O., OGUNLADE I., AND KUPONIYI F., 2007. Rural Women perception of effects of deforestation on their economic activities in Ogbomso area of Oyo state, Nigeria. *Pakistan Journal of Social Sciences*, 4(3) 474-479

BEKELE. M, 2001. Forestry outlook studies in Africa. Case study. Addis Ababa, Ethiopia.

BEKELE.W, and DRAKE. L, 2003. Soil and water conservation discussion behavior of subsistence farmers in the eastern highlands of Ethiopia: A case study of the Hunde Lafto area. Addis Ababa, Ethiopia

BERHE. K, 2004. Land use and land cover changes in the central highlands of Ethiopia: The case of the Yerer mountain and its surroundings. Masters Thesis, Addis Ababa University. Ethiopia.

BEWKET. W, 2006. Soil and water conservation interventions with conventional technologies in North Western highlands of Ethiopia: Acceptance and adoption by farmers. *Journal of Land Policy*, 24:404-416. [Online]. Available from: www.elsvier.com/locate. [Accessed: 22/09/2010].

BEWKET. W, AND TEFERI.E, 2009. Assessment of soil erosion hazard and prioritization for treatment of the watershed level: Case study in the Chemoga watershed; Blue Nile basin, Ethiopia. *Journal of Land degradation and Development*, 20:609-622.

BEZUWERK. A, TADESSE. G, AND GETAHUN. Y, 2009. Application of GIS for modeling soil loss rate in Awash River basin. Case study. Addis Ababa, Ethiopia.

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

BOARDMAN. J, SHEPHEREAD. M, WALKER. E, AND FOSTER. L, 2009. Soil erosion and risk-assessment for on-and off-farm impacts: A test case using the Midhurst area, West Sussex, *Journal of Environmental Management*, 1(18): 1-11. [Online]. Available from: www.elsevier.com/locate/envman. [Accessed; 02/10/2010].

BREHANE. G, MEKONEN. K, 2009. Estimating soil loss using Universal Soil Loss Equation (USLE) for soil conservation planning at Medego watershed, Northern Ethiopia. *Journal of American Science* 5(1).

CALATRAVA. J, FRANCO. A, GONZALEZ. C, 2005. Adoption of soil conservation practices in olive groves; The case of Spanish mountainous areas. Case study. Cartagens, Spain.

COHEN. M, BROWN. M. SHEPHERD. K, 2005. Estimating the environmental cost of soil erosion at multiple scales in Kenya using emergy synthesis. *Journal of Agriculture, Ecosystem, and Environmen*t,114: 249-269. [Online]. Available from; www.elsevier.com/locate/agee. [Accessed: 25/09/2010].

CULAS. R, 2006. Deforestation and the environmental kuznets curve. An international perspective. Research paper. Australia.

DESCOROIS L., BARRIOS G., VIRAMONTES D., POULENARD J., ANAYA E., ESTEVES M., ESTRADA J., 2008. Gully and sheet erosion on sub-tropical mountain slopes: Their respective roles and the scale effect. *Science Direct* 72 325-339

DESTA. L, KASSIE. M, BENNIN. S. and PENDER. J, 2000. Land degradation and strategies for sustainable development in the Ethiopian highlands: Case study. Amhara Region. International Livestock Research Institute. Nairobi, Kenya.

EATON. D, 1996. The economics of soil erosion: A model of farm decision making. Case study. Hague, Netherlands

FAO, 2009. Land degradation assessment. Case study. Rome, Italy

HAILE. M, HERWEG. K, AND STILLHARDT. B, 2006. Sustainable land management-A new approach to soil and water conservation in Ethiopia. University of Bern, Switzerland.

HERATH. G, 2001. Estimating the user cost of soil erosion in tea smallholding in Sirilanka, *Journal of Australian Regional Studies*, 7(1):91-111.

HARTEMINK. A, 2006. Soil erosion: Perennial crop plantation. Taylor and Francis, Wageningen, Research Paper. The Netherlands

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.

KAIMOWITZ. D, 2003. Forest law enforcement and rural livelihoods. *Journal of International Forestry Review*. 3(5):199-210..

KASSIE. M, HOLDEN. S, KOHLIN. G, AND BLUFFSTONE. R, 2008. Economics of soil conservation adoption in high rainfall areas of the Ethiopian highlands. Case study. Addis Ababa, Ethiopia.

KRANTZ L. 2001. The Sustainable Livelihood Approach to Poverty reduction: An introduction. Sweden.

MANTEL S., AND ENGELEN V., 1997. The impact of land degradation on Food Security: case studies of Uruguay, Argentina and Kenya. International soil reference and information center. Wageningen, The Netherlands.

MILLER. R AND DONAHUE. R, 1997. *Soils in our Environment*, seventh edition. Prentice Hall of India, New Delhi.

MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT, 2009. Food Security Program; 2010-2014. Addis Ababa, Ethiopia.

MINISTRY OF WATER RESOURCES AND ENERGY, 2010. Personal Communication.

MONTGOMERY. D, 2007. Soil erosion and agricultural sustainability. *Journal of Natural Academy of Sciences*, 104(33):13268-13272.

MUCHENA. M, ONDURU. D, GACHINI. N, AND JAGER. A, Turning the tides of soil degradation in Africa: Capturing the reality and exploring opportunities, 2004. *Journal of Land use Policy*, 2: 23-31.

Natural Resource Conservation Center (NRCS), 2006. Case study. Soil Erosion. USA

OKUMA B., RUSSEL N., JABBAR M., COLMAN D., MOHAMED M., and PENDER J. 1995. Technology, Policy and Population growth impacts on Economic Performance, Nutrient Flows, and Soil Erosion Level: The case of Ginchi in Ethiopia. Research Paper. Addis Ababa.

OSMAN. M, SKOWRONEK. A, AND SUERBORN. P, 2008. Land and water resource management: What did we learn, where do we go? University of Bonn, Nuballe, Germany.

PENDER. J, PLACE. F, AND SIMON. E, 1999. Strategies for sustainable agricultural development in East African highlands. Case study. International Food Policy Research Institute. Washington D.C.

PIMENTEL. D, HARVEY. C, RASOSUDARMO. P, SINCLAIR. K, KURZ. D, MACNAIR. M, CRIST. S, SHPRITZ. L, FITTON. L, SAFFOURI. R, AND BLAIR. R, 1995. Environmental and economic costs of soil erosion and conservation benefits. *Journal of Science*, 267: 1117-1121.

PIMENTEL. D AND KOUNANG. N, 1998. Ecology of soil erosion in ecosystems, Cornell University, New York. USA.

RIES J., 2009. Methodologies for soil erosion and land degradation assessment in Mediterranean type ecosystem. Trier, Germany.

SCHRECKENBERG K., LUTTRELL C., ZORLU P., 2007. A way out of poverty: A review of participatory Forest Management. Kenya

SCHURR. S AND YADA. S, 1996. Land degradation in the developing world: Implementation for food, agriculture and environment to 2020. Case study. Washington D.C.

SENAHOUN J., HEIDHUES F., and DEYBE D. Structural adjustment program and soil erosion: A bio-economic modeling approach for Northern Benin. Paper presented on a meeting at Purdue University.

SETEGN. S, SRINIVASAN. R, DARGAHI. B, AND 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. The Royal Institute of technology. Case study. Stockholm, Sweden.

SHAKSON. F, TIFFEN. M, WOOD. A, AND TURTON. C, 1997. Better land husbandry: re-thinking to land improvement and the conservation of soil and water. London, UK.

STOCKING. M, 2003. Erosion and crop yield. University of East Anglia. Marcel Deker Inc. UK.

SUNDERLIN. W, ANGELSEN. A, BALCHER. B, BURGERS. P, NASI.R, SANTOSO. L, and WUNDER. S, 2005. Livelihoods, forests and conservation in developing countries: An overview. *Journal of World Development*, 33(9): 1384-1402.

TIBEBE. D AND BEWKET. W, 2010. Surface runoff and soil erosion estimation using the SWAT Model in Keleta Watershed, Ethiopia. *Journal of Land degradation and Development*, John Wiley & Sons, Ltd. UK.

TITOLA T., 2008. Environmental degradation and its implication for agricultural development: The issue of land erosion. *Journal of Sustainable Development in Africa* 10(2) 1-31

TRIPATHI. R AND SINGH. H, 2001. *Soil Erosion and Conservation. New age International publishers.* New Delhi.

TITOLA. T, 2008. Environmental degradation and its implications for agricultural and rural development: The issue of land erosion. *Journal of Sustainable Development in Africa*, 10(2):1-31

TUMBE. C, MULENGA. S, AND HASSELMAN. M, 2005. Contribution of dry forests to rural livelihoods and the national economy of Zambia. Zambia.

WORLD FOOD PROGRAM, 2005. Ethiopia Country Program. Addis Ababa, Ethiopia

YASUOKA. J, and LEVINS. R, 2007. Impact of deforestation and agricultural development on Anopheline ecology and Malaria Epidemiology. *Journal of American Society of Tropical Medicine and Hygiene*, 76(3): 450-460.

YIRGA. C, AND HASSAN. R, 2009. Social costs and incentives for optimal control of soil nutrient depletion in the central highlands of Ethiopia. [Online]. Available from: www.elsvier.com. [Accessed: 08/10/2010].

YIRGA. C, 2007. The dynamics of soil degradation and incentives for optimal management in the central highlands of Ethiopia. PhD thesis. Pretoria, South Africa.

ZHENG. F, HE. X, GAO. X, ZHANG. C. and TANG. K, 2005. *Effects of erosion patterns on nutrient loss following deforestation on the Loess Plateau of China.* Elsevier B.V. UK.

Appendix A:

Household Questionnaire

a. Backgroung

Name of researcher----------

Date of interview----------

Code of the respondent----------

Name of the respondent----------

Physical address----------

b. General

1.1. Name of head of household----------

1.2. Sex: Male----------Female----------

1.3. Age----------

1.4. Name if different from head of household

1.5. Sex: Male----------Female--------

1.6. Age----------

1.7. Education level, please specify------

c. farming activities

2. Size of the household--------

2.1. Land holding in hectare----------

2.3. How do you make your living (your income)? A. farming alone---------- b. farming and livestock raring---------- c. trading---------- d. all---------- e. other; specify----------

2.4. For how long you have lived in this area----------years

2.5 What type of crops are you growing? a. cereals b. pulses c. both

2.6. Have you observed decline in land productivity during the last five years? A. Yes--- b. No---

2.7. If yes, what do you think is the reason a. Loss of soil fertility b. rainfall fluctuation c. removal of soil by erosion d. loss of forest resources e. all

2.8. Do you use fertilizer for crop production? a. yes--- b. no---

2.9. If yes, which type of fertilized are you using? a. Urea---b. DAP --c. both---

2.10. If you are using fertilizer, when were you first started using? a. During the last five years…b. during the last 10 years---- c. during the last 15 years---- d. more than 20 years ago

2.11. If you are using fertilizers for long then why? please explain----------

2.12. If you have been using fertilizers, is there any change in the quantity of fertilizer you are using? a. yes--- b. no---

2.13. If yes, what do you think is the reason? a. reduction in soil fertility-- b. the fertilizer is washed away---- c. both----

2.14. As a result of increase in use of fertilized, has you income reduced? a. yes----- b. no--- c. remained the same----

2.15. If yes, can you quantify in terms of cash------

d. Soil erosion

3. Do you know what soil erosion is? Yes----------No----------

3.1. If yes; what are the problems you have observed? a. Loss in production-------b. Land dissection--------- c. gully formation---------- d. loss of soil fertility---------- e. damage in infrastructure ----------

3.2. Have you ever practiced soil conservation activities? Yes----------No----------

3.3. If yes, what are the major activities you have practiced? a. Terracing b. Tree plantation c. compost making d. Check dam e. waterway f. Cutoff drain

3.4. Have you observed changes as a result of the practiced activities? a. yes------- b. No--------

3.5. If yes, what is the changes (mark all that apply) a. increase in soil fertility---- b. increase in land cover----- c. increase in land productivity-----

e. Changes in income as a result of erosion

4. As a result of erosion problems, has your income decreased? Yes---------- No----------

4.1. How do you quantify the decrease in your income? a. decrease in production per hectare-------KG b. decrease in livestock production ------ c. both--------d. Equivalent in cash per year-----

4.2. As a result of these problems, what is the level of the problem you have encountered in relation with your livelihood? a. low ------ b. medium------- c. high------- d. no change-------

4.3. What is the consequence of the reduction in your income? Mark all that apply. a. reduced no of meal------- b. reduced quantity per meal------- c. withdrawal of children from school--------- d. poor health--------- e. marginal land cultivation----- f. all--------

f. Forestry (fuel wood)

5. Do you plant seedlings in your area? a. yes---------- b. no----------

5.1. Do you observe change in vegetation cover in your area? a. yes-------- b. no----------

5.2. Do you know what deforestation is? a. yes---------- b. no----------

5.3. If yes, what is the cause of deforestation? a. search for fuel wood---------- b. search for construction wood---------- c. making charcoal---------- d. illegal logging---------- e. expansion of agricultural land------ f. all------

5.4. Do you use fire wood for cooking? a. yes---------- b. no----------

5.5. If no, what are you using? a. cow dung--------- b. straw---------

5.6.. If there is a change in type of fire wood use, then why? a. no forest product---------- b. deforestation---------- c. own interest---------

5.7. Who is responsible to collect fire wood? a. men----- b. women---------- c. children------ d. all----------

5.8. What problems do you observe as a result of deforestation? a. decrease in land productivity-------- b. increase in time of fire wood collection---------- c. increase in money to purchase fire wood---------- d. increase in frequency of drought---------- e. loss of water sources---------- f. increase in temperature---------- g. increase in wind velocity------- h. all----------

5.9. Is there a change in your income as a result of deforestation? a. yes-------- b. no---------

5.10. If yes, please quantify the change equivalent in cash per year-------

Appendix B: Key Informant questionnaire

General points of discussion (forester, soil conservationist, Agronomist working for ministry of agriculture and rural development at district level)

1. Do you know land degradation? a. yes……. b. no……..
2. If yes, what are the major causes of degradation……
2. Do you know climate change? a. yes….. b. no……
3. If yes, please explain the major causes
4. Do you observe physical change in your environment? a. yes……. b. no……
5. If yes, what do you think are the main reasons a. soil erosion--------- b. deforestation--- c. both--------
6. Do you observe social instability as a result of these problems? a.. yes…… b. no……
7. Do you observe livelihood change in your community from what has been 10 years a go? a. yes…….. b. no……
8. Have you realized any vegetative change in your community? a. yes…… be. No…….
9. If there are any changes in relation with your environment and livelihood patterns can you describe/explain?.....
.....
.....

Appendix C: Focus group discussion

This discussion was handled by the researcher

From your educational background and experience in areas of Agronomy, Livestock, and natural resource management; particularly, working with farmers entirely, please discuss the problem of soil erosion and deforestation. You can link the problem of both soil

erosion and deforestation with the livelihoods of farmers you are supporting. Soil erosion can be linked with its negative impacts in hampering agricultural production and decline in farm income. Depletion of soil fertility can further be related with decline in land productivity as a result of severe soil erosion. Additionally, the problem of deforestation can be related with the livelihoods of farmers in such a way that understanding that the major source of energy for cooking and for construction wood being biomass energy which is dominantly forest products and loosing forests negatively affects the livelihoods of forest dependent households.

Kindly tell the problem that soil erosion and deforestation are causing on the livelihoods of farmers……..

……..

……..