SOIL CONSERVATION PRACTICES BY SMALLHOLDER FARMERS IN AGRO-PASTORAL SYSTEMS: A CASE OF SERENGETI DISTRICT

By

Mbura John

Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Natural Resource Management of the University of Dodoma

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CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the University of Dodoma a dissertation entitled ***''Soil Conservation Practices by Smallholder Farmers in Agro-pastoral Systems: A Case of Serengeti District''*** in partial fulfillment of the requirements for the degree of Master of Science in Natural Resource Management of the University of Dodoma, Tanzania.

…….

Prof. Davis Mwamfupe

(SUPERVISOR)

Date……

DECLARATION

AND

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I, **Mbura John** declare that this dissertation on ‘‘Soil Conservation Practices by Smallholder Farmers in Agro-pastoral Systems: A Case of Serengeti District’’ is my original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature……..

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Last but not least special thanks are extended to Charles Alfa and his family and my relatives and friends for their material and moral support.

DEDICATION

To my parents the late John Matage Mbura and my beloved mother Naomi Machele Nguruka who raised me and saw the importance of education by enrolling me at the age of 8 years.

ABSTRACT

The study sought to explore soil conservation practices by smallholder farmers in agro-pastoral systems in Serengeti District in Tanzania. The study used a descriptive and cross-sectional design. Data collection employed both primary and secondary data. The main methods were household questionnaire surveys, key informant interviews, and direct observation. The analysis of data involved the statistical package for social sciences (SPSS) versions 16.0 and Microsoft excel.

The study identified various soil conservation practices in use by smallholder farmers in the study area. The soil conservation practiced were; shifting cultivation (48%), monoculture (31.7%), tree planting (33.3%), and application of manure (75.6%), contour farming (48%), and intercropping (82.9%). It was found that intensive use of farms with poor agricultural intensification like shallow fallow period, improper intercroping, monoculture and improper contour farming contributed to low level of soil fertility in the study area.

The study recommends that, government support is required to increasing access to technology and innovation on agricultural inputs in order to encourage smallholder farmers to practice soil conservation in response to the growing population. It is more important for the government to educate smallholder farmers on soil conservation practices by providing each village with Village Agriculture Extension Officers (VAEO).

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LIST OF ABBREVIATIONS

ACT	African Conservation Tillage
ADB	African Development Bank
D N R O	District Natural Resources Officer
DAEO	District Agriculture Extension Officer
FAO	Food and Agriculture Organization of the United Nations
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
LADA	Land Degradation Assessment in Dry lands
MAFS	Ministry of Agriculture and Food Security
SPSS	Statistical Package for Social Sciences
SSA	Sub Saharan Africa
UN ECE	United Nations Economic Commission for Europe
URT	United Republic of Tanzania
VAEO	Village Agriculture Extension Officer
WAEO	Ward Agriculture Extension Officer
WCA	World Census of Agriculture
WMO	World Meteorological Organization
WOCAT	World Overview of Conservation Approaches and Technologies

Units and measurements

1 acre = 0.405 ha

1 ha = 2.47 acres

a. s. l = above sea level

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Introduction

Pressure from increasing population in rural area demands agricultural practices which increase productivity without undermining the biological foundation on which all human depends. This chapter provides the background information to the overview problem of growing population on limited agricultural land in rural areas. Smallholder farmers being predominant users of land in rural area and Serengeti district is taken as area of study. The chapter also provides statement of the problem, objectives and significance of the study.

1.2 Background of the Study

Land is a vital resource for humankind (Sonneveld, *et al.*, 2012). Its sustainability depends on how intensively the land is exploited and the land conservation methods applied (Thomas *et al*., 2012). Agriculture is, by its very nature, a major user of natural resources, although in different ways and to different extents depending on farming system but a fertile land is crucial to provide a livelihood for most people (Kabat, 2013).

Agriculture is known to be the dominant source of food production and an important sector for sustaining growth and reducing poverty in many developing countries (UNEP, 2011). More than 70% of rural populations worldwide depend directly on land based production activities such as agriculture, livestock, fisheries, forestry, mining, and natural resources related manufacturing play a major role in national economies, employment and foreign exchange earnings (IFAD, 2010).

While agriculture remains to be a major economic sector for most of rural people in Africa, rural areas experience rapid population growth (UNEP, 2011). The high rural population growth is characterized by high population density in arable agricultural areas, thus producing an imbalance in ecological collapse and stagnates in agricultural production (Nkonya *et al*., 2008). Sub-Saharan Africa is one of the world's fastest growing population regions with population of 800 million (UNEP, 2011). Population in Sub-Saharan Africa has steadily increased over the last 50 years and is projected to grow to 1 billion by 2020, 1.2 billion people by 2025 and to reach around 1.7 billion by 2050 with population growth rate of more than 2 percent (IFAD, 2010). Agriculture is the dominant land use in the region with permanent pasture accounting for 35%, while arable and permanent cropland comprises only about 8% of the area (IFAD, 2010).

The problem of growing population and land constraints prominent in most of the rural population resides in densely populated areas attributed to inappropriate land management technique which threatens livelihood and economies of the rural people (Foley *et al*., 2011). Indeed, general estimate of 23% of agricultural land in Africa has being degraded more significantly (IFPRI, 2006). Persistently high rates of erosion affect more than 1,100 million hectare (Gibbs *et al.,* 2010). Altogether, about one quarter (24%) of the agricultural area has already suffered declines in quality and productivity over the past quarter century as a result of consequences of land competition with regard to growing population of rapid population on land use (Kirui and Mirzabaer, 2014).

Tanzania is one of the developing countries increasingly affected by rural population growth (Mongi, 2012). In Tanzania, about 80% of the population lives in rural areas

where population continues to grow (URT, 2013). Mean population density in these areas is 47.5 people per square kilometer of arable land. Farm sizes are small and shrinking gradually as households subdivide their land to the next generation (URT, 2013). With this high population density in arable agricultural areas, problem of land for cropland expansion is particularly serious in areas with large population densities.

The agro-pastoral areas such as Serengeti District are particularly vulnerable to the problem of growing population and land constraints (Altieri and Toledo, 2005; Kaswamila, 2011). The human population in Serengeti district has continued to increase by 2.3 percent from 176,609 people in 2002 to an estimated 249,420 people in 2012 (URT, 2013). This has led to land constraints attributed to human population growth including, shortage of agricultural land with increase of completion to the land as natural resources.

The smallholder farmers being predominant users of arable land are most affected by the problem of growing population (Kirui and Mirzabaer, 2014). Growing human population induces damage to all agricultural land which results into loss of valuable agricultural land (Borjeson, 2004). This would call for immediate steps to ensure that smallholder farmers use agricultural practices which conserve land resources with higher potentials in food production.

1.3 Statement of the Problem

The Serengeti District has an area of 11,156.47 square kilometers of which 7,000 square kilometers (68%) are covered by Serengeti National Park. The area available for human settlement and agricultural production is 4,156.47 square kilometers,

making 32% of the total area (URT, 2013). Only 6.4% about 660 square kilometers of the total area is arable land used for crop cultivation. With a population of around 249,420 people, Serengeti District is one of the most densely populated districts in Mara region with about 22.4 people per square kilometers and 1.9 people per acre of good arable land (URT, 2013).

Ongoing human population growth increases exploitation of natural resources, contributing to land degradation. The problem of land degradation has severe environmental and socio-economic consequences, where the soil fertility eventually becomes depleted resulting in poor agricultural productivity, food insecurity and poverty among smallholder farmers. Therefore, ways in which smallholder farmers employ during farming in this densely populated area will have an impact on land as well as on the food security. With this situation, this study intended to explore what practices smallholder farmers employ to curb land degradation.

1.4 Objectives of the Research

The following are the objectives of this study;

1.4.1 Main Objective

The general objective of this study was to examine the soil conservation practices used by smallholder farmers in Serengeti District.

1.4.2 Specific objectives

The specific objectives of this research were;

i. To examine soil conservation practices used by smallholder farmers in the study area;

ii. To determine factors influencing smallholder farmers to participate in soil conservation practices;

iii. To examine how soil conservation practices contribute in solving land degradation.

1.5 Research questions and task

Research task 1

Examine soil conservation practices used by smallholder farmers in study area.

Research questions

i. What are soil conservation strategies practiced?

ii. How are farms prepared?

iii. What measures are taken when the soil is degraded?

Research task 2

Determine factors influencing smallholder farmers to participate in soil conservation practices.

Research questions

i. What factors influence participation of smallholder farmers in soil conservation?

ii. Does each farmer possess his/ her land on permanent bases?

iii. How much land is owned by farmers?

Research task 3

Examine how applied soil conservation practices contribute in solving land degradation.

Research questions

i. What is the level of change of soil fertility?

ii. For how long the Smallholder farmers have been participating in soil conservation practices?

1.6 Significance of the Study

The study intended to provide detailed description of how smallholder farmers in Serengeti district involve in soil conservation. The research findings will contribute knowledge to the existing literature on how conservation agriculture functions in an area with high population density of which Serengeti District in Mara Region is a case study. Furthermore, the study can be used as a stepping stone to other researches on how to design methods and tools for data collection of the related conservation study. Not only that but also it will stimulate further research on soil conservation brought about by smallholder farmers in different districts in Tanzania as well as in the global attribute. Lastly, to provide recommendations on what are the best ways to do with the conservation practices on the aspect of soil conservation so as to avoid severe land degradation due to the increase in human population.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of literatures on growing population, land degradation and soil conservation practices by smallholder farmers in densely populated areas to overcome land degradation. In this chapter, theoretical backgrounds as well as empirical studies are presented. Lastly, the chapter shows the conceptual framework, as well as the knowledge gap based on the reviewed literature.

2.2 Definition of Key Terms

2.2.1 Land Degradation

Land degradation is a serious problem that contributes to the low and declining agricultural productivity and to food insecurity (Nkonya *et al.,* 2011). The major forms of land degradation are soil erosion, soil fertility mining, soil compaction, water logging, and surface crusting (Bai *et al.,* 2008). Soil erosion and soil fertility mining are believed to be the most important causes of land degradation (Nkonya *et al.,* 2011).

FAO (2002) defines land degradation as loss of production capacity of land in term of loss of soil fertility, soil biodiversity and degradation of natural resource. Cohen (2002) defined land degradation as the reduction or loss in the above areas of the biological or economic productivity and complexity of the land, resulting from land use or a combination of human activities and habitation patterns, such as soil erosion caused by wind and water, in contrast Safriel (2007) viewed land degradation as a syndrome of impairment of terrestrial ecosystem services, culminating in persistent reduction in biological productivity, as expressed in primary production. Therefore

in this study land degradation is the reduction in the soil's ability to contribute to crop production and as a change to land that makes it less useful for human beings.

2.2.2 Indicators of Land Degradation

Smallholder farmers perceive the problem of land degradation basing on their local knowledge and normally they use this local knowledge to overcome the land degradation problems (Schechambo *et al.,* 1999). According to Dejene *et al.,* (1997) farmers use a variety of indicators to interpret and explain soil problems. These indicators include; rill gully erosion, water absorption capacity, exposure of roots, crop yield, change in color or crop leaves, stunted crops, emergence of weeds and unpalatable species, appearance of termite mounds, and disappearance of grass.

2.2.3 Soil Conservations

According to Acton *et al.,* (2013), soil conservation is a combination of all methods of management and land use that safeguard the soil against depletion or deterioration by natural or man-induced factors. This involves treating the soil as a living ecosystem, and recognizing that all the organisms that make the soil their home, play important roles in producing a fertile healthy environment.

The quality of agricultural soils can conserve or even improved by using soil conservation practices. Examples of these practices include; adding organic material like manure and inorganic manure, using conservation tillage, reduced tillage or no-tillage systems, reducing the amount and frequency of use of summer fallow, rotating crops and growing legumes like clover *(ibid*).

The type of farming activity that takes place on an area of land, be it pasture or cultivation of forage or fiber crops, cereals, oilseeds, berry fruits or vegetables,

depends on the type of soil, the climate and whether crops are grown under natural rainfall or Irrigation. The more any land use disturbs the land's natural ecology, the greater its effect on soil quality (Acton *et al.*, 2013).

2.2.4 Agro-pastoral Systems

Agro-pastoral system is the productive system that derives less than 50% of income from livestock product and most of the remaining income from cultivation (Blench, 2001). Thus, in this study pastoral system is defined as production system that relies for its output on both livestock and agriculture crop farming and other resources such as, hunting, gathering, fishing, and wood collecting.

2.2.5 Smallholder Farmers

According to Lundy *et al* (2012), smallholder farmers manage about 85% of the world's farms, and are becoming increasingly significant for global agricultural value since their output supports a population of roughly 2.2 billion people.

IAASTD (2008), defines a smallholder farmer as a farmer with less than 2 hectares of land in all countries and territories except for Uruguay, USA and New Zealand where the statics are on less than 5 hectares, where as a farm of 50 ha in Argentina is considered small, and a farm of 5 ha is considered a large farm in many countries in Asia.

According to FAO(2010), Program for World Census of Agriculture(WCA) categories all farms less than 10.00 hectares as small scale farms, based on scale of operation restricted on one or more of the following factors; Land size, Heard size, marketed surplus, and income earning potential of the holding. Chamberlin (2008), using survey data from Ghana, employs farm size as the classification variable, and

defines small holders as farmers with operated farm size smaller than 10 hectares and greater than 0.1 hectares.

Jayne *et al*., (2003), define smallholder farmers in Sub- Saharan countries by taking the form of a threshold that is usually selected in an ad hoc basis (2 hectares, mean or median land size). For example, households with less than a threshold land size of two hectares may be characterized as smallholder farmer. There is no unique definition of smallholder farmers. Therefore, in this study the term smallholder farmer means the farmer that operates farms between 0.5 acres to 5.0 acres of cultivated land.

2.3 Theoretical Reviews

There are various theories governing and explaining population expansion and environmental related problems in agriculture. Some of these laws are related to the study, includes the law of diminishing return and agricultural intensification (Desiere and D'Haese, 2015).

2.3.1 Law of Diminishing Return

Malthusian population pressure theory basically predicts environmental degradation as the result of population pressure increases. The theory states that, the power of population is indefinitely greater than the power in the earth to produce subsistence for man, population, when unchecked, increases in a geometrical ratio while subsistence increases only in an arithmetical ratio (Desiere and D'Haese, 2015).

To explain an intrinsic imbalance between rate of population increase and food production, the theory postulates that the result of population increase and expansion lead to limited availability of arable land for agricultural activity due to the

competition of land use in various development activities. The scarce of arable land in a growing population lead to food insecurity. So the theory concludes that it was the fate of human numbers to be checked by starvation and warfare with populations outpacing their food supply (Otsuka and Place, 2014). However, the Malthus theory explains the negative effect of population increase on food security but he doesn't explain how to cope with population increase and application of technology innovation in agriculture by assuming that the land is inelastic.

2.3.2 Agricultural Intensification

Boserupian theory proposes that population pressure can be a primary driving force for agricultural intensification, development and environmental conservation. Theory hypothesizes that population growth is not necessarily harmful to agricultural productivity, nor will relieving demographic pressure necessarily restrain land degradation. Increasing population density leads to agricultural intensification, measured through increased demand for modern inputs, such as commercial fertilizer and increased production per hectare (Boserup, 1965). Theory describes the need of change in agricultural methods with increase in population as agricultural intensification. Under high population pressure, farmers will need to Change agricultural methods to raise production concentration at the cost of more work at lower efficiency. These changes often induce agricultural innovation (Borjeson, 2004).

In this study the Boserupian agricultural intensification is used to understand soil management practices by smallholder farmers on the overcoming land degradation problem resulted from increase of population. The land is key resources, when this resource becomes scarce, humans may adjust over time by increasing labor

efficiency, substituting other resources, innovating new technologies, creating new resource management institutions, or implementing conservation as the result the value of the land increases (Boserup, 1965).

2.4 Empirical Literature Review

Recent research on population growth in rural area and land management practices has noted the high population in agricultural land that demands agricultural practices which increases production on small farm size without undermining the biological foundation on which all human depends. The problem is predominant in dense population arable land that has lead to decrease in farm size with high demand for food on growing population. This section gives empirical analysis of the actual situation.

2.4.1 Impact of Population Pressure on Farms

According to Madulu (2005), the increase in population may lead to expansion of farm lands, decline of grazing land, and conflicting resource uses emerge. As a result, the impacts on the resource use, increases in the form of deforestation, land fragmentation, overgrazing, water scarcity and land degradation. Such features reduce the carrying capacity of the land and the capability of the rural people to meet the needs of the present and future population. Also, Jayne et al., (2012) shows that farming activity can take place in normal cultivating farms in low population density but when population growth continues, farms are expanded to uncultivated land. This agricultural development strategy that encourages production increases on the extensive margin, gained through expansion of cultivation into unused areas of land, leads to shortened fallow periods, which, in turn, tends to lead to soil degradation.

Most studies of population growth in rural area have noted negative impact of population growth on farm land but evidence from Machakos (Kenya) seem to suggest that population pressure in an agricultural areas stimulates changes in farming and income generating systems and reverse the degradation process towards sustainable resource management (Tiffen *et.al*, 1994). The study done by Place *et al*., (2006) found a significant number of investments made by Kenyan farmers in densely populated highland areas, including terracing, water management and tree planting, especially by those in areas with better market access. A number of important land investments are found to have been made and investment in tree crops remains high among hundreds of thousands of farmers. In addition, Holden *et al*. (2013) reports that when land becomes scarce and farming system is intensified, the value of land increases. In order to use and allocate valuable land efficiently, incentives must be created to reallocate land from less productive to more productive producers. Land transaction, be it renting or selling, can occur only if rights to transfer land, including rights to rent out or sell, have been established.

2.4.2 Smallholder Farmers in Densely Populated Areas

Increase of population in rural areas influences smallholder farming in different ways. Study by Munthali and Murayama (2013) smallholder farmers in rural densely populated area in Malawi reports on decline for average arable land per farmer by approximately 0.1 hector and environmental risk factor, created by the activities of the smallholder households, is, as such, very large. The per capita land remains critically low. Income levels are further affected by households' access to sufficient labor, especially in this context, where, in addition to working on one's own household farm, labours were also deployed in off-farm economic activities to generate additional

income. The majority of the crop produced ends up being used to subsistence with detrimental in soil fertility.

Study done by Desiere and D'Haese (2015) on relationship between population pressure and land intensification in Burundi, showed that in densely populated regions more households diversify agriculture. On examining associations between population pressure and yields found that yields increase substantially with increasing population pressure at relatively low population densities, yield do not seem to continue to increase in regions with a population density of more than 500 persons/km^2.

On other hand the result from study done by Kangalawe (2012) on land degradation, community perceptions and environmental management in central Tanzania, shows that there has been a general decline in the farm sizes. The increase of population in rural areas has increased the smallholder farmers to interact with land resource. Thus land is increasingly being insufficient. The decreasing farm size is one of the causes of household food insecurity in the area. The small farm sizes limit the possibilities to practice fallow rotation. Consequently continuous cultivation culminates into declining soil fertility and reduced crop productivity. The problem may as well be aggravated by loss of land as a result of soil erosion, particularly gully erosion.

2.4.3 Smallholder Farmers and Soil Conservation in Tanzania

Agriculture is the leading sector of the economy in Tanzania (URT, 2013). About 80% of population especially those in rural areas depend on agriculture for their livelihoods. Agricultural production in Tanzania is largely smallholder subsistence. In many arable lands, nutrient mining is severe, with cropping activities estimated to

be depleting nutrients at rates six to seven times greater than the rate at which they are being replenished (Mmasa, 2013).

According to Kajembe *et al*., (2005), the high rates of the population growth in Tanzania have had significant environmental implications. In many areas, the environment has been degraded to the extent that it can no longer support ecological balance and the provision of necessary resources to present and future population. Most of the farmers in dense populated area use indigenous soil conservation practices.

The study done by Shetto and Owenya (2007), in northern part of Tanzania analyses the use of conservation agriculture by farmers in subsequent environmental degradation as a practice to improve agricultural production and soil quality, conservation agriculture strives to achieve acceptable soil fertility with high sustained production levels. Smallholder farmers participated in conserving the environment based on enhancing natural biological processes above the ground by interventions such as reduced mechanical soil tillage and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes.

Study by Mwanukuzi, (2010) in southwest Tanzania found various soil conservations used to prevent land degradation and keep land productive. Most of these practices focused on the context of the physical environment and were incompatible with the social environment where they are applied. Land management methods that were accepted and adopted were those contributing to immediate livelihood needs not control land resource degradation, but increased crop output per

unit of land and required little labor. Effective methods of controlling land degradation were abandoned or ignored because they did not satisfy immediate livelihood needs.

The long-term investment in soil conservation is likely to produce good results of soil conservation measures. Existence of incentives for conservation, such as granting land tenure right influenced farmers to implement soil conservation measures. Continued participation of farmers in soil conservation is also attributed to policy changes since mid-1990s, particularly related to land tenure security, appropriate extension services on agriculture and livestock development, continued supply of subsidized improved cattle replacing destructives larges herds of the past and favorable market for crops, which provided incentives for soil conservation (Ligonja and Shrestha, 2013).

2.5 Research Gap

The ongoing land degradation and loss of fertile soils resulted from increasing human population in rural areas urgently requires a broad agricultural practices which increases productivity without undermining the biological foundation. Although there is already a wealth of available knowledge of soil conservation practices, little has been done on soil conservation practices in densely populated areas. This study therefore will investigate in detail how to overcome this gap. In depth investigation will be carried out to find what practices smallholder farmers employ in densely populated areas on solving land degradation in agro-pastoral systems such as Serengeti District.

2.6 Conceptual Framework

The conceptual framework (Figure 2.1) illustrates the conceptualized relationships between population pressure, land degradation and soil conservation practices. Population pressure on agricultural land increases competition on land. This situation induces intensive use of land leading to decline in pasture land, deforestation and decline in cultivable land. The intensive use of land threatens sustainability of soil fertility leading to soil degradation. The problem of land degradation contributes to poor agricultural production, food insecurity and poverty to smallholder farmers who directly depend on land for production. It is conceptualized that land degradation will induce smallholder farmers to apply soil conservation practices.

The conceptual framework conceptualizes the theoretical relationship between population pressure, land degradation and soil conservation practices.

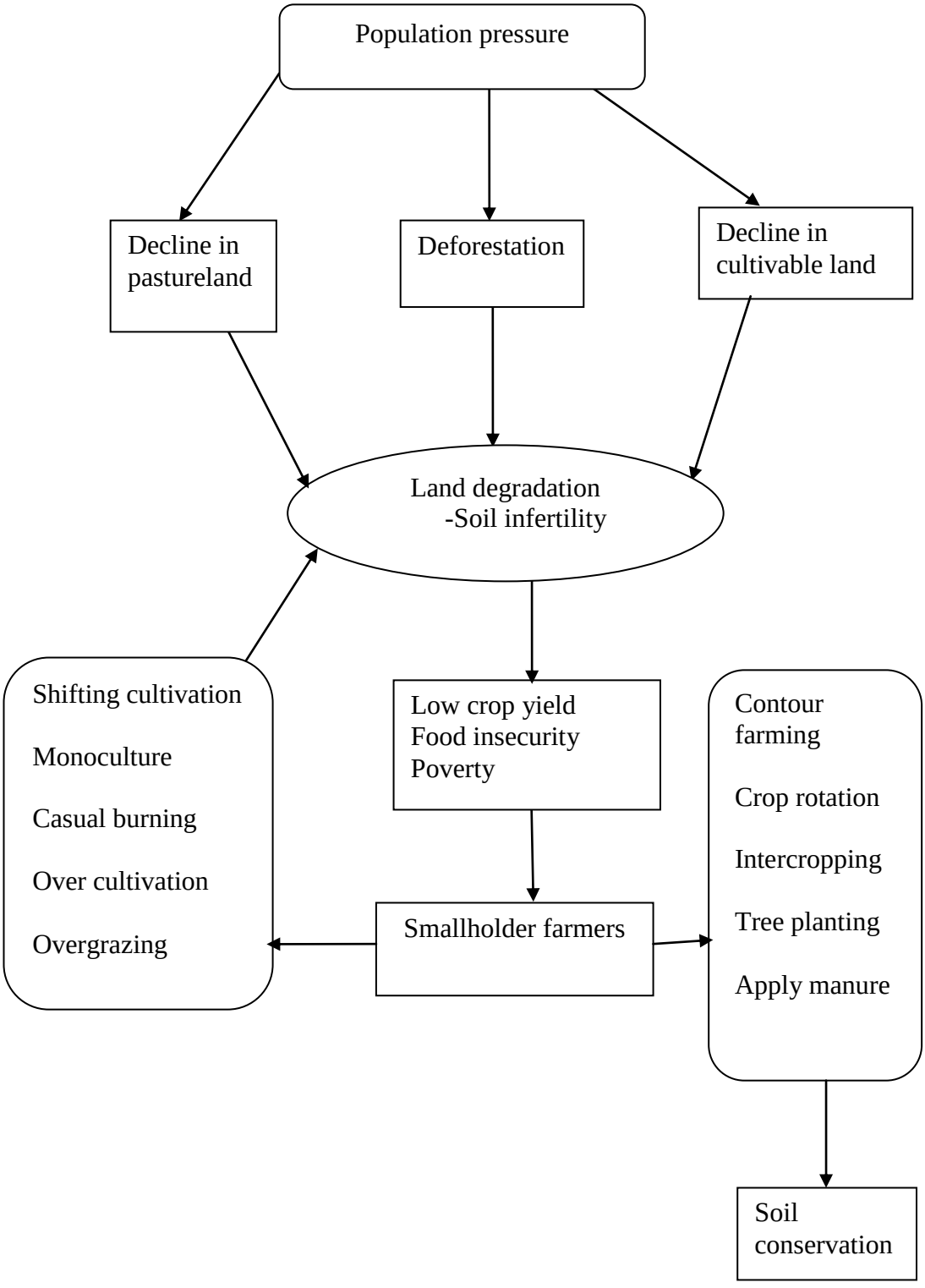

Figure 2. 1: Conceptual Framework Showing Soil Conservation Practices
Source: Researchers own matrix: March, 2015

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section describes the research methods and procedures that were used in data collection; it also examines the coverage of the study, the target population, sample selection and data collection procedure, plus data analysis.

3.2 Area of Study

The study was carried out in Serengeti District in Mara region Northern Tanzania. Purposive sampling was used to select Serengeti since the area was the dominated by smallholders farming activity, thus the sample was appropriate suited to represent the other district in the country (Holmern, *et al*., 2004).

However, the stratified sampling was used to select the four villages from two different wards found in northwest and northeast of Serengeti district highly concentrated by large number of smallholder farmers due to its good climatic condition and soil texture (Kideghesho and Mtoni, 2008), in order to save time as well as financial constraints the only four villages were selected. The villages surveyed during field research include Kitunguruma, Mbalibali, Nyankomogo and Rigicha.

3.2.1 Geographical Location of the Study Area

The Serengeti District lies between 34° 15"-35° 18 E" and 1° 30"–2° 30" S with an average altitude of 1480 meters above sea level. The total district area is about 10,373 km^2 of which about 68% (7,000 km^2) is under Serengeti National Park. The area used as arable land is estimated at 660 km^2 equivalent to 255370 hectares. The

district is bordered by Tarime District in the north, Republic of Kenya in the northeast, Arusha region in the east, Shinyanga region in the south, Bunda in the south west and Butiama district in the west.

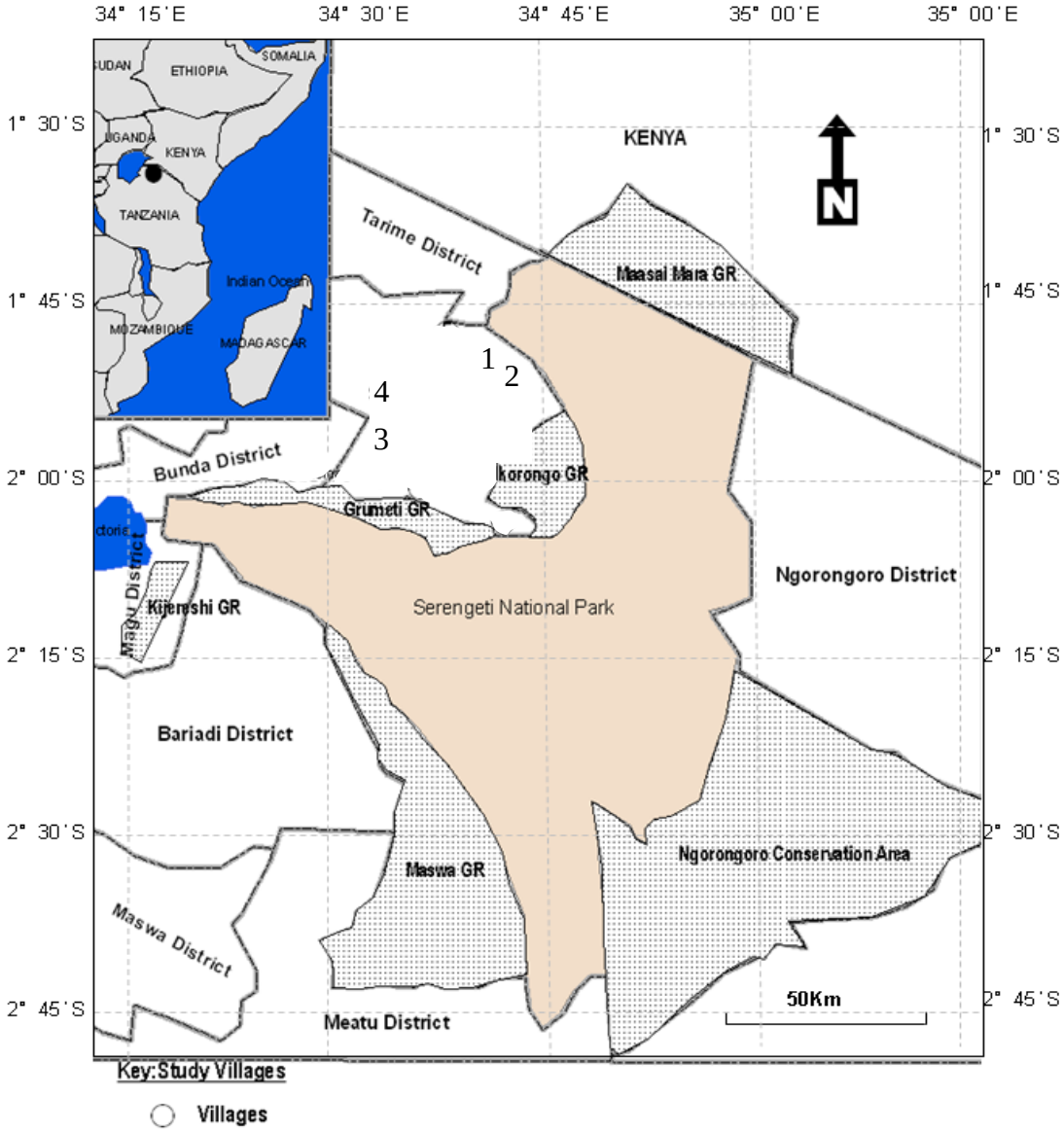

Figure 3. 1: Map of Serengeti District Showing study area

3.2.2 Population

The population in Serengeti District has increased from about 176,602 people in 2002 to 249,420 people in 2012 (URT, 2013). This population is growing at 2.8% (URT, 2012). Serengeti District is one of areas in the Mara region with large number of smallholder farmers. Among total population of 249,420 people, the 187,707 people of total population are smallholder farmers with annual crop yield estimated at 129,670 tones of various crops.

Serengeti District has an area of 11,156.47 square kilometers of which 7,000 square kilometers (68%) are covered by Serengeti National Park. The area available for human settlement and agricultural production is 4,156.47 square kilometers, making 32% of the total area (URT, 2013). Only 6.4% about 660 square kilometers of total area is arable land used for crop cultivation. With population of 249,420 people, Serengeti District is one of most densely populated area with about 22.4 people per square kilometers.

3.2.3 Economic Activities in a Study Area

The communities in the study area are typically agro-pastoral relying largely on a combination of livestock keeping and cultivation for their sustenance. Agriculture and livestock account for 80% of the household income. The remaining 20% is contributed by off-farm activities such as hunting, charcoal burning, making local brews, and formal employment (Kideghesho and Mtoni, 2008). Agriculture is mainly a smallholder farm operation involving growing of maize, cassava, millet, and sorghum for food, and cotton for cash. Most households own relatively small

land holdings, with two-thirds owning less than 4 acres (Kideghesho and Mtoni, 2008).

3.3 Research Design

According to Kothari (2004), a research design is defined as a plan which specifies and states clearly the population to be studied, the methods for the study and the procedure for processing and analyzing the data obtained.

The study used a descriptive design and cross-sectional approach. Descriptive is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals (Kothari, 2004). It was used to collect information about people's attitudes, opinions, and habits by observing the following: Constructing questions that solicited the desired information. The individuals who were to be surveyed were identified. Identify the means by which the survey was to be conducted and the data was summarized in a way that provides the designed descriptive information. Therefore, the descriptive research design appropriately suited the purpose of exploring the present status of soil conservation practices by smallholder farmers in Serengeti district.

3.4 Data Collection Method

3.4.1 Sample Design

A sample is a model of the population or a subset of the population that is used to gain information about the entire population (Neuman, 2006). It is a small collection of units, from a much larger collection or population, which is studied to enable the researcher to make more accurate generalizations about the larger group (Neuman, 2006).

This study used both probability and non-probability sampling design. Probability sampling design was used in selecting sample unit in four villages of study area whereby all smallholder farmers had equal opportunity to be sampled in every village of study area. Non-probability sampling design was applied in selecting key informants. The study adopted large sample observation whereby 124 respondents were stratified sampled. The main reason of choosing this type of sampling was that, it allowed the researcher to involve maximum sample size and from them valid data was obtained, hence resulting to excellent report.

3.4.2 Sampling Procedure

Sampling procedure was selected basing on the nature of the respondents needed for the study. The study used both purposive and random sampling in getting respondents. Since all population sample has similar characteristic.

3.4.2.1 Purposive Sampling

According to Kothari (2004), purposive sampling a deliberate selection of particular units of the universe to constitute the sample that represents the universe. This technique is also known as judgmental sampling. It falls under category of non-probability sampling. Purposeful sampling was used in collecting data from village executive officers, ward executive officer, District Agriculture Extension Officer and village elders. The researcher used this sampling technique to obtain information from the people with position in the community who had formal opinion of the situation.

3.4.2.2 Random Sampling

This is a type of sampling which provides equal chance to every member of the population to be included in the study (Kothari, 2004). This technique is found within the broad category of probability sampling. The researcher used random sampling in selecting farmers and village elders from villages covered by the study.

The random sampling was chosen over other sampling methods for two reasons: first, the method ensured the likelihood of any individual element in the population having an equal chance of being selected and being representative, hence minimizing sampling biases. Secondly, the homogenous nature of the population, all smallholder farmers across different villages in the study area are typically agro-pastoralist relying largely on a combination of livestock keeping and cultivation for their sustenance facing similar climatic condition, farming activity was mainly a smallholder farm operation involving growing of maize, cassava, millet, and sorghum for food, and cotton for cash (Kideghesho and Mtoni, 2008). Since the researcher couldn't cover all the smallholder farmers in the study area, due to limited time and financial constrain therefore, random sampling was appropriate during the field study.

3.4.3 Sample Frame

A sample frame is the list of all eligible members of a population which sample is drawn (Kothari, 2004). Population for the sampling frame was composed of district agriculture extension officer, Natural resource officer, Ward agriculture extension officer, village agriculture extension officer, and smallholder farmers in study area. These are the one supervises agriculture activities in area of study.

3.4.4 Sample Size

In this study, a sample of total 124 respondents was drawn from the smallholder farmers of the selected 4 villages since the study adopt large sample observation with at least 30 respondents (Poate and Daplyn, 1993).

Bartlett *et al.,* (2001) argues that though there is a misconception that the size of the sample should be decided on according to its relationship to the size of the population e.g. 5 or 10% of the population but what is important is absolute size of the sample regardless of the size of the sample of the population, when proper sampling procedures have been followed and the criteria used in sample size determination that required level of precision, the level of detail in the proposed analysis, and resource availability.

This sample was adequate and manageable since the study was mainly qualitatively in nature.

To minimize the effects of selectivity bias, a multi-staged random sampling procedure was adopted in the selection of participants. The first stage involved listing of all small holder farmers of each village of study Area.

The second stage involved the random selection of sample villages on a systematic basis from the listed small holder farmers. To obtain representative sample the minimum sample size required was calculated using the formula for large samples given by Poate and Daplyn, (1993).

$$n = \frac{z^2 c^2}{x^2}$$

Where:

n= the minimum sample size required

z = 1.96 the value of z at the 95% confidence interval

c = the variation within a population.

x= the expected level of accuracy

A properly drawn sample has 95% chance of producing a statistic with a value, which is within two standard errors of the true population value, so conversely there is a 95% chance that the true population value lays within two standard error of the sample value. There are 95% chance of being approximately right and a 5% chance of being wrong. This two standard error range is referred to as the 95% confidence interval of a statistics (Veal, 1997).

Table 3. 1: Population in Study Area

Name of village	Number of smallholder Farmer
Mbalimbali	472
Rigicha	360
Nyankomogo	350
Kitunguruma	450
Total	1632

Source: Field Data, 2015

Variation within a population (c) = $\frac{s.deviation}{Mean}$ x 100

Mean of population of small holder farmers = $\frac{total}{number}$ =1632/4

Mean population of small holder farmers = 408

Standard deviation= $\sqrt{\frac{x - \bar{x}}{n-1}}$

Table 3. 2: Population variations in Study Area

Number of small holder in each village in study area (x)	Variation x -x $^{-}$	$\left(x-x^{-}\right)2$
472	64	4096
360	-48	2304
350	-58	3364
450	42	1764
Total		11528

Source: Field Data, 2015

Standard deviation = $\sqrt{\frac{11528}{4-1}}$ = 3842.668

Variation in population = $\frac{3842.668}{408} x100$ = 61.98%

Therefore selection of sample size (n) =

n= $\frac{z^2c^2}{x^2} = \frac{1.96^2 x61.98^2}{0.05^2}$

$= \frac{3.8416x0.3843}{0.0025}$ = 591

Because calculated sample size exceed 5% of the population under investigation, then the collected sample size (n) is farther stratified to improve efficiencies by reducing n'

n' = $\frac{n}{1+\frac{n}{N}} = \left(\frac{591}{1+\frac{591}{1632}}\right)$ = 434

By using statistical tool the required sample is 434 out of 1632 small holder farmers in 4 villages of study area.

In order to reduce non sampling error that tend to increase with increasing sample size, considering cost and time for collection and processing the data and increase

efficiency in Supervision of questionnaire only 124 Small holder farmers were selected by using random selection of sample villages on a systematic basis from the listed small holder farmers.

Table 3. 3: Distribution of Respondents in Surveyed Area

Sampling Area	**Number of respondents**
Mbalimbali	28
Rigicha	33
Nyankomogo	32
Kitunguruma	31
Total	**124**

Source: Field Data, 2015

3.5 Methods of Data Collection

Data collection is the process of gathering and measuring information on variables of interest in an established systematic fashion that enables one to answer stated research question, test hypothesis and evaluate outcome (Kothari, 2004).

Four methods of data collection were used in the study. These included survey, Interviews, observation and documentary review. While the first three was used to obtain primary data, the last one was used to get secondary data. Secondary data included; documents containing the reports information such as books, the journals, written papers related to the problem. Tools for data collection included the use of questionnaires and interview guides.

3.5.1 Survey

Survey is the method of data collection from a sample of individuals through questionnaires (Kothari, 2004). Survey method was employed in this study since this method allowed the collection of significant amounts of data in an economical and efficient manner. Also the study adopted large sample of 124 respondents from smallholder farmers in four villages therefore, the use of survey simplified tabulation and statistical analysis of the collected data. Questionnaires used during survey contains same theme in all surveyed smallholder farmers soil conservation practices, therefore, the use of survey helps in drawing conclusion.

3.5.1.1 Questionnaires

A questionnaire is a carefully designed instrument which contains a set of questions for the process of data collection in accordance with the specifications of the research questions and hypotheses (Kothari, 2004). It is the most widely used data collection technique within the survey strategy. In this study self administered questionnaires were used to collect data from 124 household smallholder farmers in four villages.

The study used both open and closed ended question. Many questions were close ended in order to ensure good and easy way of data collection and analysis. Few questions were open ended question in order to understand deeper views and experience of the respondents on the problem. The use of questionnaire provided advantage of collecting data within a relatively shorter time. Questionnaires are among the quickest tools of data collection and free from bias.

3.5.2 Interview

According to Kothari (2004) interview refers to the method of data collection that involves oral verbal stimuli and reply in term of oral verbal responses. Interview guides were data collection instruments used to collect data during interview. Face to face interview by the use of semi-structured interview guides was used to collect some of the data. The use of interviews enabled the researcher to get direct information from the respondents. This made clarifications when needed to improve researcher's understanding of the respondents' perception of the problem.

Furthermore, Interviews was conducted with District Agriculture extension officer, Ward Agriculture Officers, Village Agriculture Officers and Village Elders. The data from interviews supplemented data collected from questionnaire and documents review.

3.5.3 Observation

This method was used to collect data that required a researcher to go direct to the field for collecting the relevant information. The researcher carried out participatory observation in order to obtain information on the soil conservation practices. During the visit interviews were conducted with various smallholder farmers applied soil conservation practices Observation was an important instrument in data collection because it provided the relevant relationship and compatibility of the data collected through other methods such as questionnaires and interviews.

3.5.4 Documentary Reviews

This is another research instrument, which was used in the collection of data of this study. This involved the some of the information such as the economic activity and number of human population of the area and the geographic position and general

size of the district were obtained from the documents. The documentary review focused particularly on reports, articles and books on ward records of crop yields, farmer's population, livelihood, and improvement measures.

3.6 Data Analysis and Presentation

According to Kothari (2004), data analysis involves a number of closely related operations which are performed with the purpose of summarizing the collected data and organizing them in such a manner that they answer the research questions. The operations include editing, coding, classifying and tabulating. It also entails categorizing, ordering, manipulating and summarizing data, to find answers to the research questions (*ibid*).

This study of the Soil Conservation Practices by Smallholder Farmers was a cross sectional, leaning on descriptive type of research. Data was collected from interviews and questionnaire, which was mostly qualitative, analyzed in line with the research questions. Data falling in a quantitative category was coded and analyzed to yield percentages, frequencies tables and figures for systematic interpretation, organization and presentation. This was done in order to make linkages among various parts leading to a comprehensive report.

The analysis of data involved the Statistical Package for Social Science (SPSS), 16.0 versions and Microsoft excel. These efficiently and accurately helped in the process and enabled the further analysis of data collected through questionnaires preceded by data edition and coding.

3.7 Validity and Reliability

Validity and reliability are the major technical considerations in quantitative and qualitative research (Babbie, 2001). Hence, it was important for the research findings

to be valid and reliable. Validity and reliability are two factors which any quality research should consider while designing a study, analyzing results and judging the quality of the study. The elucidation of the two was as follows;

3.7.1 Validity

Validity is a measure of accuracy and the instruments of measurements are actually measure what they intended to measure (Kothari, 2004). Therefore, to ensure validity, various research methods was used during field study, this triangulation was based on questionnaire, interviews and observation. Validity also means the extent to which a test measures what it claims to measure *(ibid*). It is vital for a test to be valid in order for the result to be accurately applied and interpreted.

3.7.2 Reliability

Reliability is the extent to which results are consistent overtime (Babbie, 2001). In this study reliability was ensured through the use of different methods and tools during data collection including interviews questionnaires, interview guides, observation, check list and review of a secondary data. Reliability was also ensured by the use of purpose sampling of the subgroup of village and ward leaders and the use of simple random sampling to get households respondents.

3.7.3 Ethical Considerations

Ethical issue was considered by making sure all rules and regulations within the entire society were carefully observed. Also the researcher before data collection from the field asked permission from District Executive Officer for conducting research respective area. The respondents were not forced to participate in the study.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.1 Introduction

This chapter presents the major findings obtained from the field survey and documentary review. The chapter is organized into four sections: section one presents socio-economic characteristics of the respondents. Section two addresses soil conservation practices by smallholder farmers in a study area, section three dwells on determining factors influencing smallholder farmers to participate in soil conservation practices, and the last section examines contribution of soil conservation practices on solving land degradation.

4.2 Socio-economic Profile of Respondents

This part provides key information about the respondents used in this study. This information includes the overview picture of respondents in terms of age, sex, and awareness on problem of land degradation. Socio-economic characteristics are important for showing the influence of respondents on the findings as described in sections below.

4.2.1 Age of the Respondents

Age is one of the factors that determine the ability of a person to involve in related productive activities. The field study involved different age groups from 20 years to 59 years as the working group (Table 4.1). Selection of age was purposive by considering age maturity. The age below 20 years was considered to have no enough agricultural information about soil conservation, and therefore, they were not involved. The age above 59 years were considered to lack physical energy to participate in farming activities. Though person aged above 59 years may have

reliable information about soil conservation practices, this study sought information from smallholder farmer currently practicing soil conservation.

Table 4. 1: Age Distribution of the Respondents

Age of the Respondents (years)	Frequency (n=124)	Percentage %
20-24	16	12.9
25-29	19	15.3
30-34	26	21.0
35-39	20	16.1
40-44	16	12.9
45-49	16	12.9
50-54	8	6.5
55-59	3	2.4
Total	124	100

Source: Field Data, (2015)

The result shows that smallholder farmers of different age groups were involved in farming activities in surveyed area (Table 4.1). Most of smallholder farmers (37.1%) were of the age group between 30 to 39 years, smallholder farmers between 20 to 29 years comprised 28.2%. In addition, 25.8% of the respondents constituted smallholder farmers aged between 40 to 49 years the least group (8.9%) comprised smallholder farmers between 50 to 59 years (Table 4.1). This finding suggests that people aged between 30 to 39 years are active in farming activities and only few people aged between 50 to 59 years participate in farming activities.

A total of 37.1% were of age between 30 to 39 years (Table 4.1). Result shows that 30 to 39 years is a group of active age for productive activities. Therefore this portrays that in rural areas most of youth are employed in agricultural activities. The result further shows that 8.9% of the respondents were the age between 50 and 59

years. This is the group of aged people, lacks physical energy and was less participating in farming activity. This indicates that the ability of individual (aged group) to participate in agricultural farming decreases with increasing in age maturity.

4.2.2 Sex of the Respondents

Both males and females participated in farming activity (Table 4.2). In all the surveyed areas it was found that 68.5% of smallholder farmers were men and 31.5% were women (Table 4.2). This variation occurred by chance due to the nature of the study, since the study adopted random sampling and questionnaire were randomly distributed.

Table 4. 2: Percentage Distribution of Respondents by Sex

	Villages				
Sex of respondents	Mbalimbali	Rigicha	Nyankomogo	Kitunguruma	**Total**
Male	21	25	21	18	85
	16.9%	20.2%	16.9%	14.5%	68.5%
Female	7	8	11	13	39
	5.6%	6.5%	8.9%	10.5%	31.5%
Total	28	33	32	31	124
	22.6%	26.6%	25.8%	25%	100%

Source: Field Data, (2015)

In all surveyed villages 68.5% of the smallholder farmers were males, implying that they were the leading group engaged in the smallholder farming activity. The females accounted for 31.5% (Table 4.2). While this may suggest that few females are involved in farming activities. The actual picture is that they are more involved in farming but since the questionnaire had focused on the heads of households, these occurred only by chance.

4.2.3 Awareness of Land Degradation

The knowledge of smallholder farmers on understanding environmental problems related to agriculture is a critical step for attempting soil conservation practices. Therefore the knowledge of identifying features for land degradation taking place on farm, initiates the steps for soil conservation.

Most of smallholder farmers on study area were aware of land degradation problem taking place on their farms (Table 4.3). Proportion of awareness of land degradation among smallholder farmers was almost equal in villages of Mbalimbali, Rigicha and Nyankomogo (Table 4.3). This suggests that majority of smallholder farmers involved in field study were aware of land degradation problem. This proportion of knowledge is not surprising because the effect of land degradation have direct effect on crop production.

Finding further shows that majority of males (70.3%) of all smallholder farmers in a study area were aware of the problem of land degradation and few females (29.6%) were aware of land degradation problem (Table 4.3). High awareness of land degradation among males was accounted for the greater participation of males in conservation activities through village meeting, and public seminar since most of males are head of households have a greater chance to attend compared to females who normally remain at home taking care of the family.

In addition, smallholder farmers (34.6%) with age between 30 and 39 years were aware of the problem of land degradation (Table 4.3) and only 6.9% of smallholder farmers aged between 50 and 59 years were aware of the problem of land degradation. This signifies that youth have greater awareness of land degradation because they are involved in day to day farming activities.

Table 4. 3: Awareness of L and Degradation in Survey Area

Villages	**Awareness of Land degradation among smallholder farmers**									
	Sex			**Age of Respondents (years)**				**Farm size(acres)**		
	Males	Females	**Total**	20-29	30-39	40-49	50-59	0.5-2	2.5-5	Total
Mbalimbali	19	7	26	4	13	7	2	6	22	28
	20.87%	7.69%	28.56%	3.9%	12.9%	6.9%	1.9%	4.8%	17.8%	22.6%
Kitunguruma	16	8	24	8	8	6	2	17	14	31
	17.58%	8.7%	26.28%	7.9%	7.9%	5.9%	1.9%	13.7%	11.3%	25%
Rigicha	17	7	24	6	10	6	2	12	21	33
	18.68%	7.69%	26.37%	5.9%	9.9%	5.9%	1.9%	9.7%	16.9%	26.6%
Nyankomogo	12	5	17	5	4	7	1	9	23	32
	13.19%	5.49%	18.68%	4.95%	3.96%	6.9%	0.9%	7.3%	18.5%	25.8%
Total	74	27	91	23	35	26	7	44	80	124
	70.32%	29.58%	100%	22.8%	34.65%	25.74%	6.9%	35.5%	64.5%	100%

Source: Field Data, (2015)

The level of awareness was high in all over surveyed area especially in Mbalimbali village (21%). This can be explained by land availability and ownership present in these villages. Nyankomogo village had fewer respondents (13.7%) who are aware of problem of land degradation. The low level of awareness of land degradation among smallholder farmers in Nyankomogo village is explained by nature of agriculture done in the area. This is attributed by the fact that smallholder farmers in Nyankomogo village practices shifting cultivation and contour farming therefore, when keeping on shifting from one farm to another makes them difficult to realize the problem of land degradation.

Table 4. 4: Soil Conservation Practiced in Study Area

Conservation practices	**Surveyed villages**				**Total**	**Rank**
	Mbalimbali	Kitunguruma	Rigicha	Nyankomogo		
Shifting cultivation	13 10.6%	15 12.2%	17 13.8%	14 11.4%	59 48%	3
Monoculture	7 5.7%	13 10.6%	10 8.1%	9 7.3%	39 31.7%	5
Planting of trees	15 12.2%	10 8.1%	8 6.5%	8 6.5%	41 33.3%	4
Use of manure	27 22%	24 19.5%	22 17.9%	20 16.3%	93 75.6%	2
Contour farming	9 7.3%	18 14.6%	17 13.8%	15 12.2%	59 48%	3
Intercropping	26 21.1%	22 17.9%	27 22%	27 22%	102 82.9%	1
Total	28 22.8%	31 25.2%	32 26%	32 26%	123 100%	

Source: Field Data, (2015)

In all surveyed villages a greater proportional difference of awareness of land degradation in each village was attributed to the kind of land ownership that exists. The finding shows that villages with large number of smallholder farmers who owned farm on temporary basis had greater number of smallholder farmers who were not able to identify the problem of land degradation (Table 4.3). This is hardly surprising because they might have been using the land for short period of time.

However, statistical test found positive significant association between farm size and awareness of land degradation ($p = 0.000$), indicating that farm size attributed for awareness of land degradation. There is no statistical significant association between age ($p = 0.354$), sex ($p = 0.182$), and awareness of land degradation. Therefore, awareness of land degradation in surveyed area was not contributed by age or sex of respondents.

Results found that awareness of land degradation was revealed by the ability of smallholder farmers to identify indicators of soil degradation by observing amount of crop yield, change in color or crop leaves, stunted crops, emergence of weeds unpalatable species, and disappearance of grass in their farm. In this case awareness contributes to the initial stage of solving problem.

4.3 Soil Conservation Practices in Study Area

Various soil conservation practices were found to be practiced by smallholder farmers in surveyed area. These includes: shifting cultivation, monoculture, planting of trees, farm yard& manure, contour farming and intercropping. These soil conservation practices are clearly described in section below.

4.3.1 Soil Conservation Practices Applied by Smallholder Farmers

Various soil conservation practices used by smallholder farmers in study area are indicated in Table 4.4. The overall field survey found that soil conservation practices adopted were; shifting cultivation (48%), monoculture (31.7%), tree planting (33.3%), application of manure (75.6%), contour farming (48%), and intercropping (82.9%) as shown in Table 4.4.

Finding shows that most of smallholder farmers aged between 30 and 49 years were highly involved in soil conservation practices (Table 4.5) while smallholder farmers aged between 20 and 29 years as well as those aged between 50 and 59 years were least involved (Table 4.5). This substantiate that smallholder farmers aged between 30 and 49 years are active class and have a sense of belongingness that land is the only source of their income hence soil conservation is inevitable.

Result reveals that smallholder farmers owned different farm size involved in soil conservation practices (Table 4.5). Finding shows that most of smallholder farmers own farm size between 2.5 and 4 acres were most involved in soil conservation practices (Table 4.5). Cultivation of moderate farm size by smallholder farmers in study area was probed by capital of the farmers and farm size owned by smallholder farmers. Similar study was done by Thapa (2009), showing that smallholder farmers cannot take advantage of expanding production due to difficult in access to land, land use rights and technology required for higher capital inputs.

Table 4. 5: Soil Conservation Practices Applied by Smallholder Farmers

Mbalimbali village								
Conservation Practices	**Age of Respondents (years)**					**Farm Size (acres)**		
	20-29	30-39	40-49	50-59	**Total**	0.5-2	2.5-4	4.5-5
SHFT	1 3.6%	8 28.6%	3 10.7%	2 7.1%	14 50%	2 7.1%	7 25%	4 14.3%
MONC	1 3.6%	2 7.1%	4 14.3%	0 0.0%	7 25%	1 3.6%	3 10.7%	3 10.7%
PLT	2 7.1%	6 21.4%	5 17.9%	2 7.1%	15 53.6%	2 7.1%	8 28.6%	5 17.9%
MANR	4 14.3%	13 46.4%	8 28.6%	2 7.1%	27 97.2%	5 17.9%	14 50%	8 28.6%
CONTF	0 0.0%	5 17.9%	4 14.3%	0 0.0%	9 32.1%	1 3.6%	4 14.3%	4 14.3%
INTCP	3 14.3%	13 21.4%	8 28.6%	2 7.1%	26 83.6%	5 17.9%	14 50%	8 28.6%
Total	4 11.9%	10 38.11 %	11 40.49 %	3 8.5%	28 100%	6 21.4%	14 50%	8 28.6%

Rigicha village

Conservation Practices	**Age of Respondents (years)**					**Farm Size (acres)**		
	20-29	30-39	40-49	50-59	**Total**	0.5-2	2.5-4	4.5-5
SHFT	3 9.1%	9 27.5%	3 9.1%	2 6.2%	17 52.5%	6 18.8%	8 24.2%	3 9.1%
MONC	2 6.2%	6 18.8%	1 3.1%	1 3.1%	10 30.6%	3 9.1%	4 12.1%	3 9.1%
PLT	2 6.2%	4 12.1%	3 9.1%	0 0.0%	9 27.5%	5 15.2%	3 9.1%	0 0.0%

MANR	5 15.2%	10 30.6%	6 18.8 %	1 3.1%	22 66.3%	8 24.2%	9 27.5%	5 15.2 %
CONTF	3 9.1%	8 24.2%	5 15.2 %	1 3.1%	17 52.5%	7 21.2%	8 24.2%	2 6.2%
INTCP	6 18.8%	12 36.2%	6 18.8 %	3 9.1%	27 81.3%	7 21.2%	14 42.4%	6 18.2 %
Total	6 18.6%	14 43.4%	10 30%	3 9%	33 100%	12 36.3%	14 42.5%	7 21.2 %

Source: Field Data, (2015) SHFT= shifting cultivation, MONC= monoculture, PLT= planting of trees, MANR= use of manure, CONTF= contour farming, INTCP= Intercropping

The finding shows that majority of smallholder farmers (82.9%) in all surveyed villages practice intercropping (Table 4.4). This is attributed by the increase of human population which limits farm availability and farm size. Therefore smallholder farmers in study area prefer to diversify crop in the same farm. Also it was found that 75.6% of surveyed smallholder farmers applied manure. Result shows that application of manure was the second preferred soil conservation practices by smallholder farmers. The use of organic manure to maintain soil quality by smallholder farmers in study area is due to the fact that farmyard and cow dung manure are easily available fertilizers. In addition 48% of all surveyed smallholder farmers practiced shifting cultivation. Field result indicates that shifting cultivation was third preferred soil conservation practices (Table 4.4). Shifting cultivation was commonly practiced by smallholder farmers in less populated areas (Table 3.1) showing that in low populated areas availability of land leaves a chance for

smallholder farmers to practices farm alternation. Contour farming was practiced by 48% of smallholder farmers. It was further found that only 33.3% of surveyed smallholder farmers practiced planting of trees and 31.7% of smallholder farmers practiced monoculture (Table 4.4). Tree planting and monoculture were least practiced by smallholder farmers in study area.

4.3.1.1 Intercropping

The result shows that 82.9% of smallholder farmers in surveyed area practiced intercropping (Table 4.4). Smallholder farmers in all four villages used to mix different crops in their farms. In Rigicha and Nyankomogo villages the smallholder farmers used to make ridges. On these ridges different crops were planted. The common crops such as cassava and potatoes were planted on the same ridge and some mixed cassava and maize in the same farm.

Proportion of practicing intercropping by smallholder farmers in surveyed area was almost equal in all four villages (Table 4.4). This is attributed to the fact that all four villages had comparable equal population density (Table 3.1). Therefore, smallholder farmers used to diversify crops to increase crop productivity.

The practicing of intercropping is very common in areas with land shortage. However, it was found that majority of smallholder farmer in surveyed area prefers to diversify crops in order to increase yield. This result is not far from a study done by Shetto *et al*. (2007) in Arumeru district revealed that intercropping is commonly among the smallholder farmers to maximizing land with diverse crop when the land is too scarce to be left fallow.

4.3.1.2 Application of Manure

Application of manure was the second ranked soil conservation practices in study area. About 75.6% of all smallholder farmers reported that manure from domestic animals, especially cattle was only fertilizer easily available (Table 4.4). The agro-pastoral nature of the area contributed to easily availability of organic manure.

It was further found that application of farm yard and manure was commonly practiced in village of Mbalimbali (21.1%) and Kitunguruma (19.4%). Only few smallholder farmers in Rigicha village (17.7%) and Nyankomogo village (16.1%) applied manure. Application of manure by small number of smallholder farmers in Rigicha and Nyankomogo villages was attributed by the fact that most of them owned farm under temporary basis. In addition, application of manure was practiced by most of smallholder farmer with farm size between 0.5 and 4 acres in Kitunguruma, Rigicha and Nyankomogo villages (Table 4.5) different to smallholder farmers in Mbalimbali villages in which most of smallholder farmers with farm size between 2.5 acres and 5acres applied manure. This was due to the fact that Mbalimbali and Kitunguruma villages had large number of smallholder farmers possessing cattle (Table 4.6).

The result shows that although there was large number of cattle possessed by smallholder farmers in Kitunguruma village, there was low application of manure (Table 4.4). Low application of farm yard and manure by smallholder farmers in Kitunguruma village was attributed to the large number of smallholder farmers who own farms on temporary basis. Temporary own of farmers contributes to lack of long term soil conservation.

Table 4. 6: Number of Smallholder Farmers Possessing Cattle

Surveyed villages	Number of smallholder farmers with cattle	
	Frequency	Percentage (%)
Mbalimbali	27	24.54 %
Kitunguruma	30	27.27%
Rigicha	29	26.36%
Nyankomogo	24	21.18%
Total	110	100%

Source: Field Data, (2015)

The finding reveals that application of manure was common to smallholder farmers who owned cattle and own farms on permanent basis. The smallholder farmers owned large number of cattle applied manure in large farm size. Similar results were also reported by Kajembe *et al* (2005), who reported that the use of farmyard manure increases with the ownership of livestock.

4.3.1.3 Shifting Cultivation

In all surveyed villages 48% of smallholder farmers practiced shifting cultivation (Table 4.4). Result shows that small number (10.5%) of smallholder farmers in Mbalimbali village practiced shifting cultivation. It was further observed that shifting cultivation was almost equally practiced in villages of Kitunguruma, Rigicha and Nyankomogo (Table 4.4).

Finding shows that males were most involved in shifting cultivation (Table 4.5). Result shows that shifting cultivation was most practiced by smallholder farmers with farm size between 0.5 and 4 acres in villages of Kitunguruma, Rigicha and Nyankomogo, and practiced by smallholder farmers with farms size between 4 and 5

acres in Mbalimbali village (Table 4.5). This suggests that although Mbalimbali village had large human population (Table 3.1) also had large areas for cultivation.

The result further shows that although Kitunguruma village had large number of population, majority of smallholder farmers (12.1%) in Kitunguruma practiced shifting cultivation. The practice of shifting cultivation by majority of smallholder farmers in Kitunguruma was attributed by large number of smallholder farmers own farms on temporary bases. Finding shows that smallholder farmers owning farms on temporary bases shifts to another farm on failure to renew agreement with the land owner.

Finding shows that there was no proper shifting cultivation practiced in study area due to large human population. This finding reflects the study done by Culas (2012) on forest agriculture frontiers of the tropics, showing that shifting cultivation function properly when proper fallowing period is allowed for lands available for shifting cultivation, agricultural intensifications, but under population pressure with increasing frequency of land use for shorter fallow periods, shifting cultivation causes the land become unsustainable.

4.3.1.4 Contour Farming

Contour farming is one of soil conservation practices used by smallholder farmers in a study area. Result shows that 48% of smallholder farmers in area of study practiced contour farming (Table 4.4). Result shows that contour farming was practiced by most of smallholder farmers in Kitunguruma village (14.5%) and Rigicha village (13.7%) and Nyankomogo village (12.1%) only few smallholder farmers in Mbalimbali village (7.3%) practiced contour farming.

The variation in practicing contour farming among smallholder farmers in study area was accounted by the topographical features of the area. Following the nature of relief features, most of smallholder farmers in Kitunguruma village (14.5%) and Rigicha village (13.7%) applied contour farming by planting their crops on ridge. In Mbalimbali village, contour farming was least practiced (7.3%) as in Table 4.4. This was caused by the nature of relief feature present. The topographical feature of Mbalimbali is dominated by plateaus commonly used for grazing. Therefore, only 7.3% of smallholder farmers in Mbalimbali practiced contour farming (Table 4.4).

The practice of contour farming by majority of smallholder farmers (15%) in study area attributed by topographical feature reflects the study done by Mati (2005) on sloping lands of East Africa, reporting that terracing is necessary for reducing overland flow rates thereby, contributing to water and nutrient conservation while FAO (2000) argues that, contour farming requires the application of systematic tillage practices before the crop may be established. In this way, terracing and all soil preparation exercises such as ploughing, scarifying, and harrowing must be carried out along the lines of the contours and because of this, the terraces will serve as a general guide for the direction of planting.

4.3.1.5 Planting of Trees

Tree planting was practiced by 33.3% of all smallholders in surveyed area. The result (Table 4.4) shows that all smallholder farmers in surveyed area practices planting of trees. The practice of tree planting was higher in Mbalimbali (12.1%) and Kitunguruma (8.1%), lower in Rigicha and Nyankomogo both with 6.5%.

Finding shows that plating of trees was most practiced by smallholder farmers aged between 30 and 39 years. Smallholder farmers aged between 45 and 59 years in

Rigicha village did not practice planting of trees (Table 4.5). In addition smallholder farmers aged between 45 and 59 years were less practicing planting of trees in Kitunguruma and Nyankomogo villages (Table 4.5). Low practice of planting of trees by smallholder farmers aged between 45 and 59 years was attributed by lack of awareness of land degradation (Table 4.3).

Practice of tree planting by most of smallholder farmers in Mbalimbali (12.1 %), and Kitunguruma (8.1%) was attributed by the fact that there was small number of smallholder farmers practiced shifting cultivation (Table 4.4). During survey, most of tree observed was old tree left in the farm. There were few exotic species observed in surveyed area. This indicates that only small number (10.4%) of smallholder farmers voluntarily participated in tree planting. However, majority of smallholder farmers were observed to conserve trees by leaving some tree in farm during slashing and clearing farms for cultivation for protecting wind and providing shadow around home boundary to the farms that were close to household.

This result were similar to the study done by Summers *et al.,* (2004) showed that, tree planting requires large land, but most of smallholder farmers are poor with very low ownership and access to private land such that they have little choice but to plant staple food crops that provide annual return, instead of the relatively slow growing trees.

4.3.1.6 Monoculture

Result shows that only 31.7% of smallholder farmers in surveyed area practiced monoculture. Monoculture was the least soil conservation practice applied in

surveyed area. The result shows that monoculture was commonly practiced in Kitunguruma (10.5%) and least applied in Mbalimbali (5.6%) as in Table 4.4.

The practice of monoculture among smallholder farmers in Kitunguruma (10.5%) is explained by the results in Table 4.8 revealed that the smallholder farmers in surveyed area who were poorly involved in receiving technical advices, farmer field school, and demonstration pilot were those practicing monoculture.

4.3.2 Farm Preparation Technique

The process of land degradation depends greatly on how smallholder farmers prepare farms. When proper techniques of farm preparation are employed by smallholder farmers helps on soil management and controls continuous loose of soil fertility. Therefore proper farm preparation facilitates to soil conservation.

During field survey various farm preparation methods were found practiced by smallholder farmers (Table 4.7). These were casual burning, clearing of vegetation, and ploughing. The multiple response analysis of survey result shows, 18.9% apply casual burning, 44.1% use clearing of grasses and removes grass cover and 37% till the land by ploughing (Table 4.7).

4.3.2.1 Clearing of Grasses and Vegetations

Most of smallholder farmers (44.1%) practiced clearing of grasses and cutting down of vegetation when preparing farms. In over all surveyed area it was found that clearing of grasses and vegetation was commonly practiced in Nyankomogo (25%) and Rigicha (23.4%) and least applied in Mbalimbali (16.1%).

The technique of clearing vegetation during farm preparation in Nyankomogo and Rigicha is the typical characteristic of shifting cultivation. Result shows further that

only 21.18% of smallholder farmers in Nyankomogo possess cattle. In comparison to Mbalimbali village 24.54% of smallholder farmers possess cattle. The findings show that most of smallholder farmers possessed cattle were less involved in technique of preparing farms by clearing grasses (Table 4.7). This indicates that grasses and vegetation in areas with higher number of cattle were used for grazing.

Table 4. 7: Farm Preparation Practices

Preparations practices	**Surveyed villages**				**Total**
	Mbalimbali	Kitunguruma	Rigicha	Nyankomogo	
Casual burning	10 8.1%	11 8.9%	12 9.7%	12 9.7%	45 18.9%
Clearing of vegetation	20 16.1%	25 20.2%	29 23.4%	31 25%	105 44.1%
Ploughing	18 14.5%	26 21%	22 17.7%	22 17.7%	88 37%
Total	28	31	33	32	124 100%

Source: Field Data, (2015)

4.3.2.2 Tilling and Ploughing

The findings indicated that 37% of smallholder farmers replied on preparing farms through tilling the land by the use of plough (Table 4.7). The result shows that tilling and ploughing was commonly practiced in Kitunguruma (21%) while Mbalimbali (14.5%).

Ploughing was most practiced by smallholder farmers in Kitunguruma (Table 4.7). Result shows that only few smallholder farmers in Kitunguruma village received soil

conservation training lack proper farming skills. Tilling and ploughing accounts for unsustainable farming practices. The tilling of the soil through ploughing disturbs the soil structure and expose the soil to erosion. This revealed that poor technique for soil conservation method involved during farm preparation.

4.3.2.3 Casual burning

Casual burning was the least applied farm preparation method (Table 4.7). Result indicates that 18.9% of all surveyed smallholder farmers in study area apply casual burning during farm preparation. It was further observed that application of casual burning was almost equal in all four surveyed area. The application of fire was attributed by the fact that new farms normally contain some bushes and grass that are hard to cultivate using plough.

These methods involved in farm preparation revealed that farming activities taking place in study area facilitated to loss of soil fertility at initial stage of farm preparation. These farm preparation methods reduce soil cover that protects soil moisture in this case soil becomes bare prone to erosion.

4.3.3 Measures to Improve Soil Fertility

The study found that apart from practicing soil conservation practices, the smallholder farmers opted on other ways in order to avoid the risk of crop loss (Table 4.8). These options include; shifting cultivation, expanding farms to marginal land and application of soil conservation measures (Table 4.8). These measures were applied when smallholder farmers observed the change in soil fertility.

Table 4. 8: Measures to Improve Soil Fertility

Optional measures	**Surveyed village**				**Total**
	Mbalimbali	Kitunguruma	Rigicha	Nyankomogo	
Shifting to another fertile land	13 10.5%	20 16.1%	14 11.3%	13 10.5%	60 27%
Expand farm to marginal land	17 13.7%	19 15.3%	18 14.5%	14 11.3%	68 30.6%
Apply soil conservation practice	23 18.5%	23 18.5%	23 18.5%	25 20.2%	94 42.4%
Total	28	31	32	33	124 100%

Source: Field Data, (2015)

The findings revealed that 42.4% of smallholder farmers in study area applied soil conservation activities which improved soil quality. However 30.6% were expanding farm to marginal land while 44.1% were slashing and cutting down tree for farm preparation (Table 4.8). Only 27% of smallholder farmers practiced shifting cultivation to the marginal land. This result indicates that 57.7% of smallholder farmers in study area do not apply soil conservation measures on controlling land degradation, instead they opt on expanding farms to marginal land while other shift to another fertile land (Table 4.8).

4.3.3.1 Application of Soil Conservation Practices

The result from the study area shows that 42.4% of smallholder farmers in surveyed area applied soil conservation practices as a way to improve soil fertility. Application of soil conservation practices was almost equal among all smallholder

farmers in Mbalimbali village (18.5%), Kitunguruma village (18.5%) and Rigicha village (18.5%) as in Table 4.8.

Finding shows that 20.2% of smallholder farmers in Nyankomogo village applied soil conservation to improve soil fertility. Application of soil conservation practices by majority of smallholder farmers in Nyankomogo village was attributed by topographical features. The nature of landscape which has hills influence smallholder farmers to practice soil conservation because without applying conservation measures they will face greater loss of soil fertility.

Furthermore, the respondents were probed to identify the reasons. The results show that the smallholder farmers that received technical advices, and participated in demonstration pilots had high optional to apply soil conservation practices (Table 4.8). This indicates that awareness on environmental problems related to agriculture leads into soil conservation.

4.3.3.2 Shifting to Marginal Land

The study revealed that 30.6% of respondents in surveyed area used to opt on expanding farms to marginal land (Table 4.8). The expansion of farms to marginal land was practiced by smallholder farmers in all surveyed villages. Smallholder farmers tend to expand farming to marginal land when their farm doesn't fulfill their need especially when they demand large farm size, and the past farm yield was unsatisfactory.

Result shows that shifting to marginal land was practiced by most of small holder farmers in Kitunguruma village (15.3%). Finding shows that most of smallholder farmers in Kitunguruma village cultivate small farm size between 0.5 and 2 acres

(Table 4.5). With high human population in Kitunguruma village shifting to marginal land was accounted for the low knowledge of the farmers on soil conservation practices (Table 4.8).

4.3.3.3 Shifting cultivation

Shifting to another fertile land was one of applying measures to improve soil fertility done by smallholder farmers in a surveyed area. The result shows that shifting cultivation was least applied. Finding further reveals that only 27% of smallholder farmers in surveyed area applied shifting to another fertile land as option to improve soil fertility (Table 4.8).

The study found that 16.1% of smallholder farmers in Kitunguruma village applied shift cultivation as the way to improve soil fertility (Table 4.8). Result further shows that 10.5% of smallholder farmers in Mbalimbali village applied shifting cultivation, in addition 11.3% of smallholder farmers in Rigicha village applied shifting to another fertile land and only 10.5% of smallholder farmers in Nyankomogo applied shifting cultivation (Table 4.8).

The application of shifting cultivation by smallholder farmers in Kitunguruma village was probed by large number of smallholder farmers own farm on temporary bases. Mbalimbali, Nyankomogo and Rigicha villages has large human population with small number of smallholder farmers own farm under temporary basis. Presence of large human population with low number of smallholder farmers reduces the chance of shifting cultivation.

4.4 Factors Influencing Participation of Smallholder Farmers in Soil Conservation

Involvement of smallholder farmers in soil conservation practices was influenced by various factors. These factors included; participation in soil conservation training, land tenure, as well as farm size. These factors influenced smallholder farmers to participate in soil conservation through different ways. The analysis of these factors is as described here below.

Table 4. 9: Factors Influencing Participation of Smallholder Farmers in Soil Conservation

Conservation Practices	**PTCP COT**	**Land tenure**		**Farm size (in acres)**			
		Permanent bases	Temporary bases	0.5-2	2.5-4	4.5-5	**Total**
SHFT	19 54.3%	45 36.6%	14 11.4%	22 17.9%	25 20.3%	12 9.8%	59 48%
MONC	14 40%	29 23.6%	10 8.1%	13 10.6%	17 13.8%	9 7.3%	39 31.7%
PLT	17 48.6%	34 27.6%	7 5.7%	15 12.2%	20 16.3%	6 4.9%	41 33.3%
MANR	31 88.6%	73 59.3%	20 16.3%	32 26%	42 34.1%	19 15.4%	93 75.6%
CONTF	13 37.1%	46 37.4%	13 10.6%	25 20.3%	24 19.5%	10 8.1%	59 48%
INTCP	29 82.9%	84 68.3%	18 14.6%	30 24.4%	49 39.8%	23 18.7%	102 82.9%
Total	35 28.5%	93 75.6%	30 24.4%	44 35.8%	56 45.5%	23 18.7%	123 100%

Source: Field Data, (2015) SHFT= shifting cultivation, MONC= monoculture, PLT= planting of trees, MANR= use of manure, CONTF= contour farming, INTCP= Intercropping, PTCP COT= participation in soil conservation training

4.4.1 Participation in Soil Conservation Training

The extent to which smallholder farmers practice soil conservation depend on soil conservation knowledge gained (Sterve, 2010). The survey study found various approaches used to make smallholder farmer knowledgeable on soil conservation practices (Table 4.10). These participatory approaches were; technical advice, farmer field schools, demonstration plots, and agriculture extensional public seminars as shown in Table 4.10.

Findings found that in allover surveyed area only 28.5% of smallholder farmers participated in soil conservation training (Table 4.9). Results show that majority of smallholder farmers that participated in soil conservation training practiced intercropping, use of manure and shifting cultivation. Only few practiced monoculture, plating of trees and contour farming.

4.4.1.1 Technical Advices

Findings show that technical advice (60.3%) and farmer field schools (53.4%) were most used approaches to most of smallholder farmers in Mbalimbali and Nyankomogo villages (Table 4.9), while agricultural public seminars (48.3%) were least applied to smallholder farmers in Kitunguruma and Rigicha villages. Results further show that smallholder farmers in Mbalimbali village (36.2%), Kitunguruma village (22.4%) and Nyankomogo village (24.1%) were exposed to soil conservation participatory approaches also few smallholder farmers in Rigicha village (17.2%) were exposed to soil conservation participatory approaches (Table 4.9).

Table 4. 10: Number of Smallholder farmers Exposed to Participatory Approaches

Approach used	Surveyed villages				Total	Rank
	Mbalimbali	Kitunguruma	Rigicha	Nyankomogo		
Technical advices	22 37.9%	12 20.7%	7 12%	17 29.3%	58 60.3%	1
Farmer field schools	20 24.5%	12 20.7%	10 17.2%	16 27.6%	31 53.4%	2
Agricultural public seminars	19 20.7%	7 5.2%	9 6.9%	16 15.5%	28 48.3%	3
Total	21 36.2%	13 22.4%	10 17.2%	14 24.1%	58 100%	

Source: Field Data, (2015)

Technical advice was first ranked techniques for applying soil conservation practices used in the study area. The results reveal that majority of smallholder farmers in surveyed area received soil conservation knowledge through technical advices. Findings show that technical advice was mostly applied to smallholder farmers in Mbalimbali village (20.7%) and Nyankomogo village (17.2%). Only few smallholder farmers in Rigicha village (8.6%) received technical advices (Table 4.10).

The overall field survey found that technical advice provided to smallholder farmers was given by village agricultural extension officers (VAEO). This indicates that smallholder farmers who had VAEO in their villages had high privileges of obtaining technical advices compared to the villages that had no VAEO. The results

further reveled that in the four surveyed villages only Mbalimbali and Nyankomogo villages had VAEO, therefore lack of enough agricultural extensional officers (VAEO) in surveyed villages limit provision of technical advices to smallholder farmers.

Applying of technical advice for adoption soil conservation practices by smallholder farmers in study area by VAEO also reflects the study done by FAO (2000) which showed that technical advice by itself is enough but also frequent and regular stimulation through visits by extension workers are necessary to raise knowledge of farmers for improvement of conservation practices.

4.4.1.2 Farmer Field Schools

Farmer field school was another approach through which farmers gained knowledge on soil conservation practices (Table 4.10). This approach was common among smallholder farmers in nearly all villages (Mbalimbali, 15.5%; Nyankomogo, 15.5%; Kitunguruma, 12.1% and Rigicha village, 10.3%).

Results from the study area revealed that participation of smallholder farmers in farmer field schools was accounted by type of crops cultivated. Smallholder farmers cultivating tobacco had advantages of participating in farmer field schools since training was offered to smallholder farmers cultivating tobacco by tobacco association Alliance One. This suggests that farmer field school was selective only smallholder farmers that cultivated demanded crop participated in a program.

Finding shows that following crop diversity, variation in climate, nature of the soil and crops preferences among smallholder farmers, farmer field schools approach favored most of smallholder farmers in Mbalimbali and Kitunguruma villages who

involve in cultivating tobacco, smallholder farmers in Nyankomogo village cultivating cotton as cash crop and eliminating those that do not priories on cash crop.

4.4.1.3 Agricultural Public Seminars

Smallholder farmers were also provided knowledge about soil conservation through agricultural public seminars (Table 4.10). Agricultural public seminar was third ranked approach for adoption soil conservation practices in surveyed area. Result shows that 48.3% of smallholder farmers were provided knowledge of soil conservation by agricultural public seminars. Result further shows that most of smallholder farmers in Mbalimbali village (20.7%), and Nyankomogo (15.5%) received soil conservation through agricultural public seminars. Only few smallholder farmers in Kitunguruma village (5.2%) and Rigicha village (6.9%) participated in agricultural public seminars (Table 4.10).

The field survey found that there was no organization responsible on providing seminars on soil conservation practices. Most of agricultural public seminars provided to smallholder farmers in Mbalimbali villages and Nyankomogo village were received from VAEO. This suggests that to villages that had VAEO had high chance of attaining agricultural public seminars.

The overall field study found that participation of smallholder farmers in soil conservation training was attained by most of smallholder farmers cultivating tobacco. These Smallholder farmers used to meet for exchanging knowledge pertaining preparation of seedling, planting and harvesting of tobacco. On interview with ward agricultural officer it was observed that demonstration farms were

normally prepared and facilitated by Alliance One Tobacco Company during farm preparation.

Study done by FAO (2000) on conservation approaches indicated that farmers that develop most rapidly and successfully soil conservation practices were those that received the greatest direct and personal contact from extension workers. The successful development of new agricultural practices required the presence of government or non-governmental institutions that were skilful in techniques of technology transfer.

4.4.2 Land Tenure

Land ownership is an important factor for soil conservation, since property right plays a central role in the use and conservation of any natural resource. The field study found that smallholder farmers in all study area had right to own land. Both permanent and temporary land ownership existed in area of study. Results further indicated that majority of smallholder farmers (75.8%) owned land on permanent bases and only few smallholder farmers (24.2%) owned land on temporary bases (Table 4.11). Permanent land ownership by majority of smallholder farmers indicates that most of smallholder farmers in study area had better chance for long term soil conservation practices (Table 4.9).

Result shows that proportion of smallholder farmers owned farms on permanent bases was almost equal in all surveyed villages. Result further shows that most of smallholder farmers in Kitunguruma village (8.1%) and Nyankomogo village (7.3%) owned farms on temporary basis. Only few smallholder farmers in Mbalimbali

village (4%) and Rigicha village (4.8%) owned farms on temporary basis (Table 4.11).

Table 4. 11: Land Tenure in Surveyed Area

Name of village	**Land ownership**		**Total**
	Permanent own	Temporary own	
Mbalimbali	23	5	28
	18.5%	4.0%	22.6%
Kitunguruma	21	10	31
	16.9%	8.1%	25.0%
Rigicha	27	6	33
	21.8%	4.8%	26.6%
Nyankomogo	23	9	32
	18.5%	7.3%	25.8%
Total	94	30	124
	75.8%	24.2%	100%

Source: Field Data, (2015).

The overall field survey found that the large number of smallholder farmers own farms on temporary basis in Nyankomogo and Kitunguruma villages (Table 4.11) was attributed to an increase in land pressure caused by increasing human population and number of livestock in these surveyed area. Suggesting that, following agro-pastoral farming systems, increase of human population in study area limits direct occupation of land. Since most of smallholder farmers in Kitunguruma and Nyankomogo villages were not entitled to land for permanent basis, they were to lent farms and shift to other farms when the contract ended.

4.4.3 Farm Size

Farm size is important factor influencing decision of smallholder farmers to apply a particular soil conservation practice**.** Smallholder farmers with large farm size may decide to practice shifting to other farms with low chance for innovations while smallholder farmers possessing small farm size have high chance for agricultural intensification (Table 4.9). The result shows that smallholder farmers in surveyed area possess different farm size (Table 4.12). The amount of land owned by smallholder farmers in surveyed area was 0.5-2acres (35.5%), 2.5-4acres (45.2%) and 4.5-5 acres (19.4%). This is reflected in Table 4.12.

Table 4. 12: Farm Size Owned in Study Area

	Farm size (acres)			**Total**
Name of village	0.5-2	2.5-4	4.5-5	
Mbalimbali	6	14	8	28
	4.8%	11.3%	6.4%%	22.6%
Kitunguruma	17	10	4	31
	13.7%	8.1%	3.2%	25.0%
Rigicha	12	14	7	33
	9.7%	11.3%	5.6%	26.6%
Nyankomogo	9	18	5	32
	7.3%	14.5%	4.0%	25.8%
Total	44	56	24	124
	35.5%	45.2%	19.3%	100%

Source: Field Data, (2015).

Result shows that most of smallholder farmers (45.2%) in study area owned farm size between 2.5 and 4 acres, few smallholder farmers (35.5%) owned farm size between 0.5 and 2 acres while only 19.4% of smallholder farmers owned farm size between 4.5 and 5 acres. Result further shows that proportion of smallholder farmers

owned farm size between 2.5 and 4 acres was almost equal in all villages with exceptional of Kitunguruma village. In addition most of smallholder farmers in Kitunguruma village (13.7%) owned farm size between 0.5 and 2 acres. Proportion of smallholder farmers owned farm size between 4.5 and 5 acres was equal in all villages (Table 4.12).

The overall field survey found that 80.7% of smallholder farmers owned farm size less than 4 acres, only 19.3% of smallholder farmers owned farm size greater than 4.5 acres (Table 4.12). Owning of small farm size by majority of smallholder farmers (80.7%) in surveyed villages is attributed by large human population which increases land pressure. This suggests that majority of smallholder farmers in surveyed areas must apply agricultural intensification to enable them produce more in continues decrease of farm size.

4.5 Contribution of Soil Conservation Practices on Solving Land Degradation

The survey study found various soil conservation practices used by small holder farmers in the surveyed area (Table 4.4). This section analyses on how applied soil conservation practices contributed to altering the problem of land degradation in the surveyed area by looking on change in soil fertility over time with adopted soil conservation practices.

4.5.1 Change in Soil Fertility in Surveyed Area

The overall field survey found that the level of soil fertility was not constant in all surveyed area (Table 4.12). The smallholder farmers experienced both increase and decrease in level of soil fertility in their farms. The study result reveals that most of smallholder farmers (78.2%) experience the decrease in level of soil fertility Only

few smallholder farmers (21.8%) in all surveyed area observed the increase in the level of soil fertility in their farms (Table 4.12). This indicates that majority of smallholder farmers (78.2%) applied soil conservation practices that do not suffice to sustain soil fertility.

Result shows that proportion of increase in soil fertility was almost equal among all surveyed smallholder farmers. Result further found that the increase of soil fertility was high among Smallholder farmers owned farm size less than 4 acres, while the level of increase in soil fertility was low to those with farm size greater than 4 acres (Table 4.13).

The increase of soil fertility among smallholder farmers with small farm sizes was attributed by decision to retain conservation practices which are determined by amount of farm owned to enable them produce more compared to smallholder farmers with large farm size (Table 4.11). This is similar to a study done by Nkonya *et al.,* (2002) in Uganda which showed that farmers with smaller plots used more intensive soil fertility management methods than those with larger plots. It was observed that some 5.5% of smallholder farmers in Mbalimbali village and Kitunguruma village (7.3%) sustained soil fertility in their farms while few smallholder farmers in Nyankomogo villages (4%) and Rigicha village (4.8%) experienced increase in soil fertility. Increase in soil fertility observed by most of smallholder farmers in Mbalimbali village and Kitunguruma village was attributed by application of manure by most farmers in these villages following large number of household owning cattle (Table 4.4).

Table 4. 13: Change in Soil Fertility in Surveyed Area

Surveyed village	Level of change of soil fertility		Total
	Increase	Decrease	
Rigicha	6	27	33
	4.8%	21.7%	26.6%
Nyankomogo	5	27	32
	4.0%	21.7%	25.8%
Kitunguruma	9	22	31
	7.3%	17.7%	25.0%
Mbalimbali	7	21	28
	5.6%	16.9%	22.6%
Total	27	97	124
	21.8%	78.2%	100%

Source: Field Data, 2015

Increase in soil fertility by application of manure was accounted by the fact that manure is very rich in organic matter and macro nutrients essential for improvement of soil properties and plant growth. This result reflects the study done by Ajayi *et al*., (2007) which showed that well-decomposed organic matter release the necessary nutrients for plant growth and also help improve the soil structure, hence improve aeration and water retention. In addition the study done by Grande et al., (2005) on residue level and manure application shows that, manure reduces soil erosion by increasing formation, stability, and strength of aggregates due to the addition of organic matter.

Table 4. 14: Contribution of Applied Soil Conservation Practices on Solving Land Degradation

	Change in soil fertility			Farm size (acres)			Total
Conservation practices	Increase	Decrease	**Total**	0.5-2	2.5-4	4.5-5	
SHFT	11	48	59	5	5	1	11
	8.9%	39%	48%	18.5%	18.5%	3.7%	40.7%
MONC	9	30	39	4	3	2	9
	7.3%	24.4%	31.7%	14.8%	11.1%	7.4%	33.3%
PLT	8	33	41	3	4	1	8
	6.5%	26.8%	33.3%	11.1%	14.8%	3.7%	29.6%
MANR	24	69	93	9	11	4	24
	19.5%	56.1%	45.6%	33.3%	40.7%	14.8%	88.9%
CONTF	13	46	59	7	4	2	13
	10.6%	37.4%	48%	25.9%	14.8%	7.4%	48.1%
INTCP	20	82	102	6	9	5	20
	16.3%	66.7%	82.9%	22.2%	33.3%	18.5%	74.1%
Total	27	96	123	11	11	5	27
	22%	78%	100%	40.7%	40.7%	18.5%	100%

Source: Field Data, (2015) SHFT= shifting cultivation, MONC= monoculture, PLT= planting of trees, MANR= use of manure, CONTF= contour farming, INTCP= Intercropping

Result from Table 4.12 shows that most of smallholder farmers in Rigicha village (21.1%) and Nyankomogo village (21.1%) observed the decrease in soil fertility. The result analysis shows that among various soil conservation practices, intercropping was the most applied soil conservation practices applied by most of smallholder farmers in Rigicha village and Nyankomogo village (Table 4.4). With low level of soil fertility observed in these villages, indicates that practicing of intercropping was not efficient soil conservation practices to enhance soil fertility.

This reflects a field experiment result established by Wang *et al*., (2014) in Gansu province, northwest China on soil fertility in intercropping revealing that intercropping may be an efficient cropping system for sustainable agriculture when carefully managed fertilizer inputs are applied. In addition, Lithourgidis *et al.*, (2011), argues that, for sustainable farming intercropping requires selection of the appropriate crop species and the appropriate sowing densities, including extra work in preparing and planting the seed mixture and also extra work during crop management practices, including harvest. The selection of an appropriate intercropping system for each case is quite complex as the success of intercropping systems depend much on the interactions between the component species, the available management practices, and the environmental conditions.

In all surveyed villages 15% of smallholder farmers practiced shifting cultivation (Table 4.4). With increasing soil infertility among smallholder farmers adopting shifting cultivation (Table 4.13) shows that there was no proper fallowing period resulted from increase of human population exerts pressure on land. In view of the intensity of land use, shifting cultivation systems are strongly influenced by population density, as classified by Boserup (1965) in very sparsely population density shifting cultivation is typically shifted in long fallow period and continuous cultivation while dense population density does not provide long enough time for the soil to restore its functionality. Therefore, because of high population pressure and scarce arable land smallholder farmers in study area practiced shifting cultivation in short fallow cycle which does not allow infertile soil to recover.

Similar result was observed by Culas (2012), showing that shifting cultivation function properly when proper fallowing is allowed for land available for shifting

cultivation and agricultural intensifications, but under population pressure with increasing frequency of land use for shorter fallow periods, shifting cultivation causes the land become unsustainable. In addition, Jeus *et al*., (2012) shows that shifting cultivation practiced has impact on reduction of land cover vegetation in due course promotes soil erosion and reduces soil fertility and productivity with impact on long term environmental sustainability.

Basing on overall survey finding, it is clear that shifting cultivation practiced by smallholder farmers in surveyed area, has a substantial impact on reduction of land cover vegetation, on promotion of erosion, on reduction of soil fertility and productivity, and calls in question the long term environmental sustainability, following the increasing soil infertility among smallholder farmers adopting shifting cultivation.

Contour farming was one of soil conservation practices applied by most smallholder farmers in study area for soil erosion control in area with various topographical features (Table 4.4). Contour farming in study area involved making of ridges. These ridges retard the runoff velocity, reduce the runoff transport capacity, enhance water in filtration, reduce sediment transport, and discharge excess runoff at non-eroding velocities. Blanco and Lal, (2008) found that contour farming effectively reduces rate of erosion in soils with slopes of up to 10%. On steeper slopes, contour cropping can still be used to control erosion but must be accompanied by other conservation practices such as grass waterways to safely discharge runoff water from the contour rows. In addition, Ghanbari *et al.,* (2010) found that contour cultivation used on down slope tillage and rolling topography may be limited by the instability of farm machinery, which can slip down, but effectiveness of contour farming for water and

soil conservation depends on the design of the systems, but also on such factors as soil, climate, slope aspect and land use of the individual fields, while FAO (2000), argues that contour farming requires the application of systematic tillage practices before the crop to be established.

Following this explanation it is clear that, decrease in soil fertility experienced by most of smallholder farmers in study area was attributed by lack of appropriate contour cultivation accompanied by other conservation practices such as grass and waterways to safely discharge runoff water from the contour rows as well as absence of application of systematic tillage practices.

Monoculture was one of soil conservation practices adopted by smallholder farmers in study area. The decline in soil fertility among smallholder farmers adopted monoculture was attributed for the fact that monoculture production systems lead to a decrease in faunal diversity through attraction of few different microbial species. This in turn affects the predator diversity. Monoculture makes the soil susceptible to erosion hazard, weed invasion, and pest and disease infestation. Therefore, monoculture requires a periodic application of synthetic chemicals to supply nutrients and combat diseases (Bationo *et al*., 2007).

4.5.2 Time for Applying Soil Conservation Practices

Sustainability of soil conservation practices applied is measured against time for applying the adopted soil conservation practices in farming. This is attributed to the fact that when soil conservation practices is applied for a long time with impact on maintaining soil fertility then that soil conservation practice is sustainable. The survey result shows that smallholder farmers adopted soil conservation practices for

various years of experience between 1 year and 40 years (Table 4.14). Time for adopting soil conservation practices was grouped into various farming experience groups.

The field results also show that at beginning of farming between 1 year and 20 years of practicing adopted soil conservation practices, majority of smallholder farmers (81.5%) observed increase in soil fertility in their farms and only 7.4% of smallholder farmers between 21 years and 40 years of farming experience observed increase in soil fertility. It was further shown that all smallholder farmers adopted soil conservation practices, 88.9% of smallholder farmers applying manure observed increase of soil fertility, intercropping (74.1%), contour farming (48.1%), shifting cultivation (40.7%), monoculture (33.3%) and planting of trees (29.6%) observed increase of soil fertility in their farms (Table 4.14).

Table 4. 15: Increase of Soil Fertility with Years for Applying Soil Conservation Practices

conservation practices	Time for adopting soil conservation practices (years)					Land ownership	
	1-10	11-20	21-30	31-40	**Total**	permanent	**Total**
SHFT	10	0	1	0	11	8	8
	37%	0.00%	3.7%	0.00%	40.7%	44.4%	44.4%
MONC	8	0	1	0	9	8	8
	29.9%	0.00%	3.7%	0.00%	33.3%	44.4%	44.4%
PLT	7	1	0	0	8	6	6
	25.9%	3.7%	0.00%	0.00%	29.6%	33.3%	33.3%
MANR	19	3	1	1	24	17	17
	70.4%	11.1%	3.7%	3.7%	88.9%	94.4%	94.4%
CONTF	11	1	1	0	13	9	9
	40.7%	3.7%	3.7%	0.00%	48.1%	50%	50%
INTCP	15	3	1	1	20	16	16
	55.5%	11.1%	3.7%	3.7%	74.1%	88.9%	88.9%
Total	22	3	1	1	27	18	18
	81.5%	11.1%	3.7%	3.7%	100%	100%	100%

Source: Field Data, (2015) SHFT= shifting cultivation, MONC= monoculture, PLT= planting of trees, MANR= use of manure, CONTF= contour farming, INTCP= Intercropping

Finding shows that majority of smallholder farmers (81.5%) in area of study observed an increase in soil fertility when practiced soil conservation between 1year and 10 years (Table 4.14). Only few smallholder farmers (7.4%) with farming experience between 21 years and 40 years observed increase of soil fertility. This finding reflects the observation in Table 4.5 suggests that smallholder farmers observed increase of soil fertility are proportion to smallholder farmers practicing soil conservation.

4.5.2.1 Change in Soil Fertility with Time for Applying Soil Conservation Practices

The deterioration of the soil fertility does not occur as single event. It occurs as result of continued use of land for human activity. The change in soil fertility with years for adopting soil conservation practices determines the extent to which the adopted soil conservation practices contribute on altering land degradation in study area. The variation in number of smallholder farmers observing soil fertility with farming years reveals the nature of soil conservation practices by smallholder farmers in the study area (Table 4.14). Regarding large number of smallholder farmers observed increase in soil fertility between 1 year and 20 years of farming indicates that at beginning, most of farms gives large yield. This situation leads them to neglect application of sustainable farming. Therefore majority of smallholder farmers involve in farming during this period with low inintiatives for maintaing soil fertility, to the extent that after 20 years of farming soil fertility detoriates and become less productive.

Although, smallholder farmers in surveyed area applied various soil conservation practices (Table 4.5), there were assurance of soil prevention from deterioration attributed to the increase of human population and increasing land pressure. The intensive use of these small farms caused soil to be prone to deterioration. This intensive use of farms with poor agricultural intensification contributed to degradation of soil structure and loss of other soil qualities which caused soil nutrients depletion due to shallow fallow period, improper intercroping, monoculture and low planting of trees practiced by most of smallholder farmers (Table 4.4).

Based on this analysis, the result indicates that smallholder farmer do not invest in sustainable soil conservation practices due to low technical advices given, shortage of farmer field schools, agricultural public seminars and lack of participatory approaches (Table 4.9). Majority of smallholder farmers concentrates on yield gain rather than soil conservation. The more farming years the more soil infertility suggesting that there were problem of soil fertility management linked with the poor agricultural intensification applied by smallholder farmers in area of study (Table 4.14).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study was carried out with the objective of exploring soil conservation practices by smallholder farmers of Serengeti District. It also aimed to; examine soil conservation practices used by smallholder farmers in study area; to examine factors influencing smallholder farmers to participate in soil conservation practices; finally, to examine how soil conservation practices contribute on solving land degradation. Major findings, conclusion arrived and recommendations are summarized in this chapter. Finally it proposes areas for further research.

5.2 Summary of Findings

The findings of the study have been presented in accordance with the three study objectives. The first objective aimed to examine soil conservation practices used by smallholder farmers. The study found that smallholder farmers in study area use various soil conservation practices to overcome the problem of land degradation. Existed soil conservation practices were; shifting cultivation (15.0%), monoculture (9.9%), tree planting (10.4%), application of farm yard and manure (23.7%), contour farming (15.0%), and intercropping (26.0%).

It was further found that intercropping and application of farm yard manure were most soil conservation practiced by smallholder farmers. Shifting cultivation, contour farming, tree planting and monoculture were least practiced.

The second objective was to determine factors influencing smallholder farmers to participate in soil conservation practices. The study revealed that various factors

influenced smallholder farmers to participate in soil conservation practices. These factors included; participation of smallholder farmers in soil conservation training, land tenure, and farm size. Smallholder farmers participated in soil conservation training through; technical advice, farmer field school, and agriculture extensional seminar.

Technical advice was the most common approach used for participation of smallholder farmers in soil conservation practices. This approach was most used to smallholder farmers in Mbalimbali village (37.9%), Nyankomogo village (29.3%) and Kitunguruma village (20.7%). Only some smallholder farmers in Rigicha village (12%) received technical advices. The study also shows that there was an inadequate agricultural extensional officer in surveyed villages. This problem had contributed to in limited provision of technical advice to smallholder farmers. Limitation of technical advices lead to poor agricultural techniques applied to farming due to lack of proper information and knowledge about practices that can improve agricultural production and conserve the environment at the same time.

The last objective examined how soil conservation practices contribute on solving land degradation. The data from survey revealed that although smallholder farmers practice various soil conservation practices, most of smallholder farmers (78.2%) experience the decrease in level of soil fertility. Only few number of smallholder farmers (21.8%) in all surveyed area observed the increase in the level of soil fertility. Most of smallholder farmers in Kitunguruma (7.3%) and Mbalimbali (5.6%) observed the increase in soil fertility. Smallholder farmers in Rigicha (21.7%) and Nyankomogo (21.7%) observed the decrease in soil fertility.

It was further found that among other soil conservation practices application of manure was influential on altering problem of land degradation. The result shows that in area where smallholder farmers used application of farm yard and manure observed the increase in soil fertility. The result analysis shows that the decrease in level of soil fertility increases with increase in number of farming years. Indicating that majority of smallholder farmer does not invest in sustainable agriculture for long time.

5.3 Conclusion

From the study findings we can conclude that majority of smallholder farmers applied various soil conservation practices. These includes: shifting cultivation, monoculture, planting of trees, farm yard& manure, contour farming and intercropping to overcome the problem of land degradation. Intercropping was adopted by majority of smallholder farmers. This was attributed by the increase of human population which limits farm availability and farm size.

Various factors influenced smallholder farmers to participate in soil conservation practices. These include; participation of smallholder farmers in soil conservation training, land tenure, and farm size. Lack of enough agricultural extensional officers (VAEO) in surveyed villages limits provision of soil conservation knowledge to smallholder farmers.

Result found that, most of smallholder farmers do not invest in long term soil conservation practices due to low technical advices given, shortage of farmer field schools, agricultural public seminars and lack of participatory approaches hence,

problem of soil fertility management linked with the poor agricultural intensification applied by smallholder farmers in area of study.

The study agrees with Boserup theory, revealing that there were assurance of soil prevention from deterioration attributed to the increase of human population and increasing land pressure. Generally, in order to reduce land degradation, agricultural intensification requires continuous land conservation practices.

5.4 Recommendations

- Government support is required in increasing access to technology and innovation on agricultural inputs in order to encourage farmers to practice soil conservation in response to the growth of population.
- Government in cooperation with other stakeholders like farmers agricultural associations should make sure that there are enough agricultural extension officers for training and facilitating conservation to farmers.
- The district council should develop appropriate bylaws and design effective strategies that promote management and conservation of land use.
- The government should allocate the man power like agricultural extension officers in rural areas and should develop infrastructure for them for better performance.

5.5 Suggestions for Further Research

This research covered a small part in soil conservation by small holder farmers. There is a need for other research to be conducted. The suggests other study should focus on:-

- Methodologies that are focused on improving the utility of adopted soil conservation practices.
- Assessment on improving perception of smallholder farmers on problem of land degradation.

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APPENDICES

Annex 1: Questionnaire for Smallholder Farmers Operating Less Than 5 Acres Annually

SECTION A: Background of the Respondent

Village……

Ward……

Sex of respondent

1. Male ☐

2. Female ☐ Age of respondent……yrs

SECTION B: To examine soil conservation practices used by smallholder farmers in study area

1. Do you practices soil conservation to maintain soil fertility in your farm?

1. Yes. ☐

2. No ☐

2. If yes, which of the following farming practices do you use for cultivation of your land?

a) Shifting cultivation 1.Yes….. 2. No……

b) Monoculture 1.Yes…… 2. No……

c) Tree planting 1.Yes…… 2.No……

d) Mixed farming. 1. Yes…… 2No…….

e) Application of farmyard and manure, 1.Yes……2.No……

f) Contour farming 1Yes…….

2No……

g) Crop rotation 1.Yes…….. 2.

No……..

h) Others

(specify)……

……

3. How do you prepare your farms?

i/ Do you involve fire during preparation of your farm? Yes……

NO…….

ii/ Do you slash and remove some tree in preparation of your farms?

Yes…….No……..

iii/ .Do you involve ploughing? Yes……. No…….

iv/ Others (specify)…….....

4. Have you taken any of the following measures because of soil erosion?

I/.Abandoned your farm land yes…… No……

ii/.Expanded to marginal land Yes…… No……

Iii/Apply control measures Yes…… No……

SECTION C: Determine factors influencing smallholder farmers to participate in soil conservation practices

5. Do you get any technical advice from any extension agent about soil conservation practices?

1. Yes ☐

2. No ☐

6. Ever you attended any of training of soil conservation practices?

1. Yes ☐

2. No ☐

7. Ever you attended any of the following for improving conservation practices

On farm trials 1.Yes…… 2.no……..

Farmers' field school 1. Yes…… 2.no……..

Demonstration pilot 1. Yes……. 2.no…….

Extension publication 1.Yes…… 2 .no……..

8. Which of the following tools do you use on farm activity?

Hand hoe 1.Yes……. 2.No……..

Oxes 1.Yes…… 2.No……

Tractor 1, Yes…… 2 No……

9. Is fertilizer readily available in your village?

1. Yes ☐

2. No ☐

10. Do the land you cultivate belongs to you

Yes ☐ No ☐

11. What is the total Area of your cultivated land…… acres?

12. What are major crops grown……

13. Are you cultivating all your land?

1. Yes ☐ 2. No ☐

14. If **NO** what are the reasons……

SECTION D: Examine how soil conservation practices contribute to solve land degradation

15. For how long have you been cultivating on this farm……. ……..…….....**..**

16. Do you observe changes in the level of land degradation on your cultivated land?

Yes ☐

No ☐

17. If yes has it been

Increasing ☐

Declining ☐

18. What are the major reasons? .....

Annex 2: Questionnaire for Agriculture Extension Officers

Name of District/ Ward……

1. Smallholder Farmers Statistical Data 2010 to 2014.

2. The trend on soil status (level of soil conservation among smallholder farmers). Records for soil conservation practices if any

3. Do smallholder farmers practices in soil conservation to maintain soil fertility in your area?

1. Yes. ☐
2. No ☐

4. If yes, which of the following soil conservation practices do they use?

a) Shifting cultivation 1.Yes….. 2. No……
b) Monoculture 1.Yes…… 2. No……
c) Tree planting 1.Yes…… 2.No……
d) Mixed farming. 1. Yes…… 2No…….
e) Application of farmyard and manure, 1.Yes…2.No……
f) Contour farming 1. Yes…. 2. No…
g) Crop rotation 1. Yes….. 2. No…
h) Others (specify)……

6. Is there any training to smallholder farmers on soil conservation practices?

1. Yes ☐
2. No ☐

7. Do smallholder farmers participate in any of the following training?

On farm trials 1.Yes…… 2.no……..

Farmers' field school 1. Yes…… 2.no……..

Demonstration pilot 1. Yes……. 2.no…….

Extension publication 1.Yes…… 2 .no…….

8. Do you observe changes in the level of land degradation among smallholder farmers?

Yes ☐

No ☐

9. If yes has it been

Increasing ☐

Declining ☐

10. What are the reasons?

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11. What are to be done in order to improve soil conservation in your area?

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