AN EVALUATION OF GENDER AND SOCIAL PERSPECTIVES IN CHOICE OF SOIL FERTILITY MANAGEMENT TECHNOLOGIES FOR MAIZE PRODUCTION IN NANDI COUNTY, KENYA

ROSE KEMMEY

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DECLARATION

DECLARATION BY CANDIDATE

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Rose Kemmey Date

SES/PGHE/30/11

DECLARATION BY SUPERVISORS

This thesis has been submitted with our approval as the University supervisors.

__________________________ ________________________

1**. Dr. Cheserek, Grace.** Date
Senior Lecturer,
Department of Applied Environmental Social Science
School of Environmental Studies
University of Eldoret

___________________________ ____________________________

2. Dr. Kiptui Mark Date
Lecturer,
Department of Applied Environmental Social Science
School of Environmental Studies
University of Eldoret

DEDICATION

This thesis is dedicated to God Almighty for the gift of life and His provision during my period of study and to whom the success of my labour rests. To my dear husband Mr. Kemei for his full support and finally my children who gave me both moral and financial support.

ABSTRACT

The adoption and diffusion of soil fertility management technologies among smallholder farmers in Kenya lags behind scientific and technological advances thus reducing crop productivity. The main purpose of this study was to evaluate gender and social perspective in choice of soil fertility management technologies for maize production in Kabiyet division of Nandi County. The specific objectives were to; determine soil fertility management technologies in maize production, evaluate social diversities in soil management practices that enhance maize production, determine gender roles that influence the choice of soil fertility management technologies, identify and evaluate socio-economic characteristics that influence choice of technologies in maize production systems and to determine strategies of mainstreaming gender in soil fertility management technologies. This study adopted a descriptive survey method. The sampling frame was drawn from 6,505 households. 100 households were selected by multi-sage cluster sampling from six locations of the study area. Interviews, questionnaires and observation were used to collect data. The study utilized descriptive methods of data analysis which entailed the use of measures of central tendencies such as frequencies and percentages. Qualitative data was summarized and interpreted in line with the research objectives and questions. Results of data analysis were presented in form of figures and tables. The study findings showed that intercropping and terracing were the most commonly used soil management strategies that enhanced maize production where maize and legumes (beans) were mostly intercropped. In addition, most of the farmers acquired soil management technologies from agricultural extension officers and during field days. Moreover, men were the main decision makers in implementation of maize production technologies. Further, men and youth contributed a larger percentage of labour for land tillage in maize production. Use of soil sampling and analysis, mixed cropping and early planting were the most commonly used strategies in enhancing soil fertility management technologies while the least used technologies was use of zero tillage. It was therefore recommended therefore that there was need for agricultural field days to be organized more in the study area to enable maize farmers to obtain more soil management technologies for maize production. It is expected that the study findings will be of importance to maize farmers in Kabiyet Division, Ministry of Agriculture and other relevant Ministries in identifying strategies of soil management technologies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ADMARC	Agricultural Development and Marketing Cooperation
AREI	Agricultural Resources and Environmental Indicators
CA	Conservation Agriculture
CF	Conventional Farming
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
INRM	Integrated Natural Resource Management
ISFM	Integrated Soil Fertility Management
KARI	Kenya Agricultural Research Institute
MOA	Ministry of Agriculture
NARO	National Agricultural Research Organization
SCAO	Sub-County Agriculture Officer
SFFRFM	Smallholder Farmers Fertilizer Revolving Fund of Malawi
SSA	Sub-Saharan Africa
TIP	Targeted Inputs Programme

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Most of the economies in Sub-Saharan Africa largely depend on agriculture for food and income provision. In this region, more than 50% of the populations rely on agriculture for their livelihood and the sector contributes more than 30% of the Gross Domestic Product (GDP) (Van Straaten, 2002). Soil fertility decline and land degradation are critical constraints to agricultural development in the region. The focus of efforts to solve these problems has been on increased food production through a series of interventions. A recent innovation was the application of the Green Revolution, which, however, eluded most African land managers due to its capital-intensive nature and lack of political will. Plant nutrient deficiency, poor soil management, poor soil conservation management, poor land tenure systems and inadequate extension infrastructure are among the major causes of poor land productivity in Sub-Saharan Africa (SSA) (Gachene & Kimaru, 2003). Land degradation is widespread in the region and has been on the increase despite the awareness of its effects.

Intensive land-use systems practised in many parts of Sub-Saharan Africa without adequate nutrient replenishment have led to massive depletion of plant nutrients, decline in per capita food production, and thus to malnutrition and food insecurity (Lynam *et al.,* 1998). The most affected social groups are women and children due to their limited ability to cope with the stressful effects of hunger, poverty and malnutrition. The livelihood needs of men and women in any given social system are not always the same, because of their different roles, responsibilities and resource endowments (Pasteur, 2002). The impacts of different livelihood strategies also vary across different social and gender contexts. Women and men are therefore likely to differ in their capacity, choice and adoption of different technologies, and hence attention must be paid to such diversities. The most pressing concern in developing countries today is how to feed their growing populations from a fixed natural resource base. This means, therefore, that land and water resources must become increasingly productive in environmentally resilient way. However, there are certain factors that militate against such goals, including depleted soils, low adoption of agricultural technologies across different gender and social classes, lack of access to credit, and lack of dynamism in socio-economic systems and a variety of other standard development challenges that rural Africa is confronted with.

Declining soil fertility and low macro-nutrient levels are fundamental impediments to agricultural growth and a major negative social externality in sub-Saharan Africa (Vanlauwe & Giller, 2006; Sanchez, 2002). The soils in sub-Saharan Africa are being depleted at annual rates of 22kg/ha for nitrogen, 2.5 kg/ha for phosphorus, and 15 kg/ha for potassium (Smaling et al., 1997). The adoption and diffusion of soil management technologies among smallholder farmers in the region has generally lagged behind scientific and technological advances thereby reducing their impact (Ajayi *et al.,* 2007; Ajayi & Kwesiga, 2003; Franzel & Scherr, 2002).

The economy of Kenya is agro-based and heavily dependent on rain fed agriculture. The agricultural sector contributes about 25 percent of the overall gross domestic product.

Agriculture is the engine of Kenya’s economy whose aim is to ensure food security, creation of employment and provision of incomes and livelihood to the majority of the Kenyans. To enable agriculture play this important role in the economy of Kenya in a more sustainable way, there is need for rapid growth in agricultural output and productivity (Ouma *et al.,* 2002). This can be achieved through sustained flow and utilization of improved agricultural technologies of which improved seeds and agronomic practices that accompany them are very important. According to IFPRI (2002), success in Kenya’s agriculture lies in improvement of agricultural technologies and their subsequent diffusion to the farmers.

Numerous data suggest that female household heads in rural areas are disadvantaged with respect to human capital accumulation in most developing countries, regardless of region or level of economic development (Anríquez, & Erdgin, 2013).The level of human capital available in a household -usually measured as the education of the head of household or the average education of working-age adults in the household is strongly correlated with measures such as agricultural productivity which ultimately affect household welfare and economic growth at the national level (World Bank, 2007).

Gender is not a new concept in African agriculture. However, it has only recently been recognised as an important concern in agricultural research (KARI, 2008). Gender embraces all socially-given attributes, roles, activities and responsibilities connected to a person, either male or female, in a given society. Important gender categories include men and women, boys and girls, young and elderly, male-headed and female-headed households. In any social system gender has great potential for having a significant impact on farm incomes and food security. Different roles and responsibilities are placed on the different genders by different social systems. These roles and responsibilities are critical determinants of access to and control over productive resources, such as land, cash crops, and livestock products. The social systems also determine entitlement to resources and power among men, women, and children. This, therefore, implies that food security would improve if different gender roles were properly integrated into agricultural research and development programmes.

Traditionally, increase in agricultural output has been achieved through the expansion of cultivated area. Little of the best arable lands left today must be divided among the farming populations which continue to expand. Such an approach has led to widespread degradation of land (Lynam & Blackie, 1994). According to Flintan (2003), in the past, environmental and soil fertility decline were addressed through shifting cultivation, mainly by men-dominated initiatives. In some instances women played little or no role and were therefore marginalised (Flintan, 2003) while in other instances the whole of the agricultural economy depended on female labour. At the same time, due to an increase in population pressure, some traditional practices of natural resource management became obsolete and untenable. This has culminated in environmental degradation, nutrient depletion, hunger, and widespread poverty. Alternative profitable and sustainable ways must, therefore, be found quickly to restore lost soil fertility and natural resource productivity.

Declining soil fertility and low macro-nutrient levels are fundamental impediments to agricultural growth and a major negative social externality in sub-Saharan Africa

(Vanlauwe & Giller, 2006; Sanchez, 2002). In addition, the organic matter content of the soils is also declining. Apart from the primary effects of declining per capita food production, poor soil fertility triggers other side effects on-farm such as lack of fodder for livestock production, reduction in fuelwood and high deforestation rates as farmers are forced to abandon poor soils and encroach on forests which are more fertile. These have the predictable consequence of accelerating degradation of natural resources and offer very little potential for sustainable agriculture.

Despite the potential for adoption of soil management technologies, apart from a few cases of exceptional success, some of which have been cited as examples of "successes in African agriculture" (Gabre-Madhin & Haggblade, 2004), the adoption and diffusion of soil fertility replenishment (RSFR) technologies among smallholder farmers in sub-Saharan Africa has generally lagged behind scientific and technological advances thereby reducing their impact (Ajayi *et al.,* 2007; Ajayi & Kwesiga, 2003; Franzel & Scherr, 2002).

The utilisation and viability of agricultural technologies are influenced by political, social, economic and institutional constraints. Any decision to adopt technology would be based not only on profitability but also on potential tangible social and cultural benefits. According to Doss and Morris (2001), farmers will adopt technologies if they do not seriously disrupt existing farming systems, jeopardise their subsistence, or introduce additional strains on already constrained and limited resources. Gender aspects are not considered and the resulting constraints on the adoption of technologies across gender are ignored. This study therefore sought to analyse the role played by types of technologies, characteristics of farmers, and gender differences as it relates to choice and profitability of technologies.

The 1996 World Food Summit forecast was that food insecurity would become a global concern in the 21st century (FAO, 1996), especially for women and children who are the most vulnerable social groups. In addition, women are adversely affected by cultural prejudices that hinder their access to and control over production resources. High costs of inputs, lack of credit, land, labour, and technical requirements are some major constraints on the adoption of many maize production technologies.

Traditionally, smallholder farmers in Africa just are accustomed to practicing conventional farming (CF), which involves disturbing the soil through ploughing, discing, harrowing and many other tilt conditioning operations (Mashingaidze & Mudhara, 2005). It is generally believed that CF creates a favourable soil structure for seedbed preparation, controls proliferation of weeds, and increases mineralization of soil organic matter but inevitably compacts the soil, promotes salinization, accelerates soil erosion and depletes the soil of organic matter and nutrient content (FAO, 2000). CF has been observed to cause soil losses of up to 150 tons per ha annually (Knowler & Bradshaw, 2007; FAO, 2000). As a panacea to problems caused by CF, many agricultural scientists have advocated for the use of conservation agriculture (CA) technologies. However, these technologies have been less widely adopted (Fowler and Rockstrom, 2001; Derpsch, 2003; Hobbs, 2006).

The increasing complexities of environmental problems are likely to increase the necessities of new agricultural technologies that can be used to minimize the potential contribution of negative environmental consequences of agricultural production. Climate change poses threats, but the effect is still difficult to predict. Climate change will affect crop and livestock yields worldwide, which will lead to change in food and fiber consumption, prices of agricultural commodities, and farm income (USDA, 2014). According to the Agricultural Resources and Environmental Indicators (AREI) many technologies that have been developed have the potential not only to increase farm productivity, but also to reduce the environmental and resource costs associated with agricultural production such as land and water by increasing yields with the same or fewer inputs and technologies. Besides, agriculture can provide many public goods and services or externalities like land conservation, maintenance of landscape structure, biodiversity preservation , nutrient recycling and loss reduction and so on (Boody *et al.,* 2005).

Different studies have shown that different technologies can positively affect soil properties and yields. Furrow digging contributes to economic stability through reduced water consumption and yield and net returns (Nuti *et al.* 2009). Technology adoption practices include good agrarian practices, irrigation scheduling, water saving, conservation tillage, organic farming, erosion reduction, nitrogen fertilization and plastic covered horticulture (Bertuglia & Calatrava-Requena, 2006).

Technical change in the form of adoption of improved agricultural production technologies has been reported to have positive impacts on agricultural productivity growth in the developing world (Nin *et al.*, 2003). Promotion of technical change through the generation of agricultural technologies by research and their dissemination to end users plays a critical role in boosting agricultural productivity in developing countries (Mapila, 2011). The availability of modern agricultural production technologies to end users, and the capacities of end users to adopt and utilise these technologies are also critical. This study investigated the effects of gender and social perspectives in choice of soil fertility management technologies for maize production in Nandi County.

1.2 Statement of the Problem

Kenya has had a long history of successful agricultural research and the subsequent release of new crop varieties and innovative technologies. Despite this, the country continues to suffer from deficits in main food staples, such as maize, wheat and rice (KARI, 2008). There are various technologies that have been introduced by Ministry of Agriculture and other service providers like KARI. However, levels of technology adoption are low, and farmers' yields are about 50 percent or less of their potential. Since farmers' needs and objectives are diverse and always changing, diversities need to be considered in technology development processes to a greater extent than has hitherto been the case. Much work has been done on manure use and management in maize production in Kabiyet (MOA, 2012) but only limited studies have been carried out on evaluation of gender and social perspectives in choice of soil fertility management technologies for maize production in the division.

Women are key providers of labour in agriculture but are constrained by a number of socio-economic factors. They contribute about 80 per cent of labour to food crop production, and 50 per cent to cash crop production; but they receive only seven per cent of extension information including technologies available for maize production (World Bank, 2007). Women also play lesser role in decision-making in institutions, and in networks of power and authority all of which are male-dominated. In general, women are less frequently consulted in technology development and transfer than men. Gender mainstreaming was therefore an important variable in the current study.

Gender relations are not universal and are dynamic over time and space. In addition, households are not in uniform decision-making units but represent the complex interactions of individual interests and abilities, and the priorities of different male and female members. Women and men have different life experiences, different knowledge, perspectives, and priorities. Their access to and control over resources and benefits are not equal. Men cannot necessarily represent the interests of women, nor vice versa; and neither sex alone can adequately represent their community. There was therefore need to address gender issues in agricultural productivity especially maize production in Kabiyet Division, Nandi County.

1.3 Purpose of the Study

The main purpose of this study was to evaluate gender and social perspective in choice of soil fertility management technologies for maize production in Kabiyet Division of Nandi County, Kenya.

1.4 Objectives of the Study

The objectives that guided the study were to;

i. Investigate the effect of social perspectives on soil management technologies used for maize production in Kabiyet Division.
ii. Assess the gender roles that affects the choice of soil fertility management technologies in maize production in Kabiyet Division.
iii. Evaluate the socio-economic characteristics that affects the choice of soil fertility technologies in maize production systems in Kabiyet Division.
iv. Investigate strategies used by farmers in enhancing soil fertility management technologies in Kabiyet Division.

1.5 Research Questions

This study was guided by the following research questions

i. What effects do social perspectives have on soil management technologies used for maize production in Kabiyet Division?
ii. What are the gender roles that affects the choice of soil fertility management technologies in maize production?
iii. What are the socio-economic characteristics that affects the choice of technologies in maize production systems?
iv. What strategies do farmers use in enhancing soil fertility management technologies?

1.6 Significance of the Study

The study findings will be of importance to maize farmers in Kabiyet division, the Ministry of agriculture and other relevant Ministries in identifying strategies of soil management technologies. It is expected that the findings of the present study will lead to the streamlining of development policies and programmes to take full account of the impact of gender inequalities on agriculture, to work to reverse nutrient depletion more effectively, to increase food security, reduce poverty and improve rural livelihoods. The aim of the study is in line with Kenya's development policies as outlined in the government's Poverty Reduction Strategy Paper and other government policies including the Millennium Development Goals, Sustainable Development Goals and Vision 2030 (GoK, 1994, 1995, 1996, 2001).

1.7 Assumptions of the Study

The research was based on the following assumptions

1. Maize farmers in Kabiyet division have several soil management practices that enhance maize production
2. Women and men have different life experiences, different knowledge, perspectives, and priorities. Their access to and control over resources and benefits are not equal. Men cannot necessarily represent the interests of women, nor vice versa; and neither gender alone can adequately represent their community.
3. That farmers understand the soil fertility management technologies in the area.

1.8 Scope of the Study

This study was undertaken in Kabiyet Division of Nandi County between the months of October to December, 2012.The content scope covered the soil fertility management practices/technologies in maize production, social and gender diversities in the soil management practices that enhance maize production, the gender roles that iaffectthe choice of soil fertility management technologies in maize production, the socio-economic characteristics that influence the choice of technologies in maize production systems and strategies of mainstreaming gender in soil fertility management technologies.

1.9 Theoretical Framework

This study was guided by Sen's (1995) theory of intra-household bargaining which shows the inequality in decision-making process among different members of households and how this inequality affects distribution of resources. Productivity difference by gender is also frequently explained by difference in the adoption of technology, assuming the adoption of technology is likely to vary between men and women (Quisumbing, 1995). To the extent that female farmers may have less education, less access to land and own fewer tools, they may be less likely to adopt new technologies (Quisumbing, 1995). Thus, their productivity is often lower than male farmers. The inter and intra-household decision-making process on the allocation and use of these technological resource is also made along gender lines. Several studies (Kakooza *et al.,* 2004) reveal that cash crop production which is dominated by men is characterized by availability and utilization of improved farm equipment such as tractors and combine harvesters, and farm inputs such as fertilizers and pesticides. In this study, gender is considered to have an effect on the adoption of soil management technologies that affect maize production in the study area.

1.10 Conceptual Framework

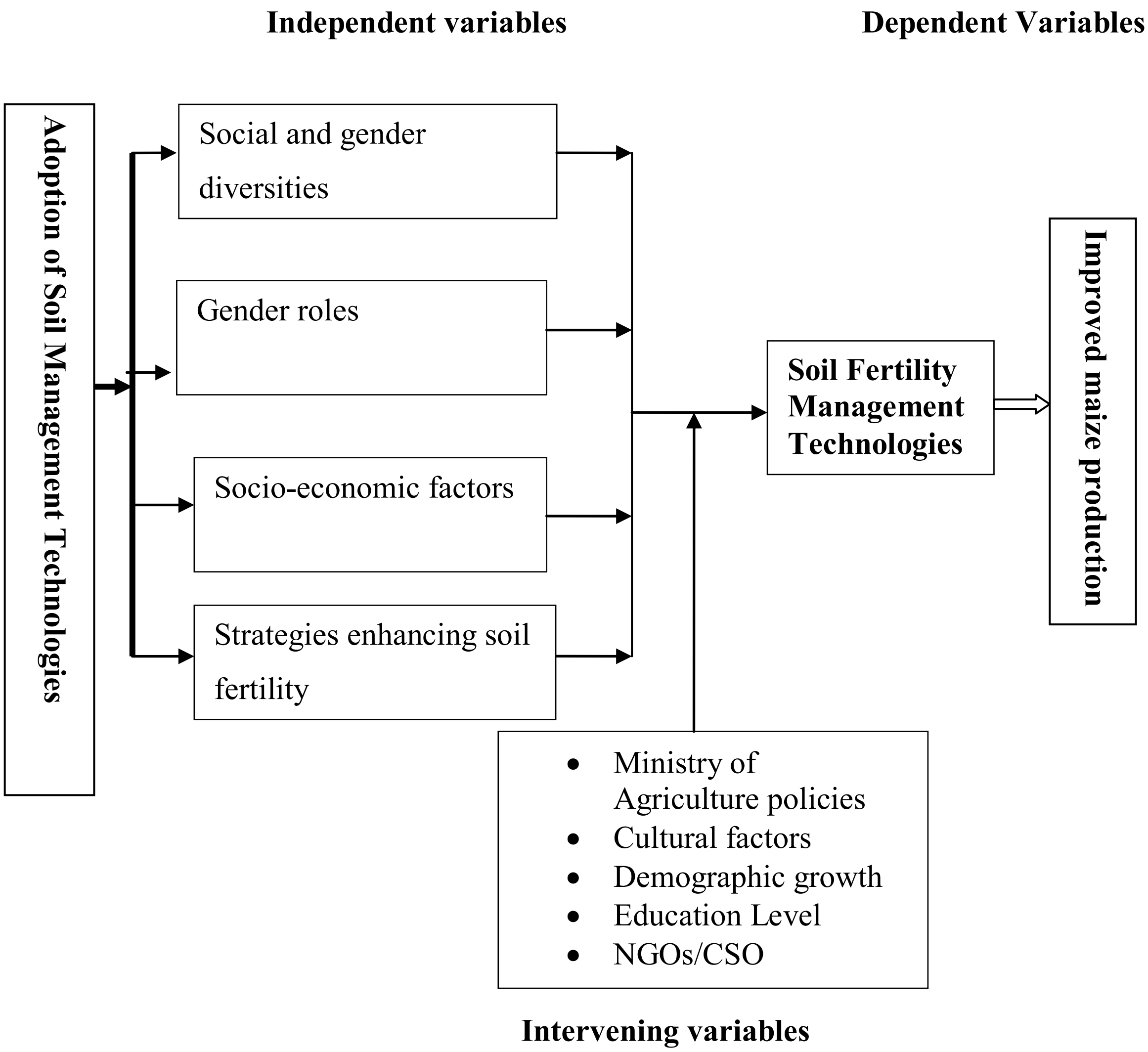

Figure 1.1: Researchers' Conceptual Framework, 2016

In this study, the dependent variables were; social and gender diversities, gender roles, socio-economic factors and soil fertility management technologies which wer deemed to affect soil management technologies in Kabiyet Division. The intervening variables were government policies, cultural factors, demographic growth and education level of the farmers. These variables were integrated while designing research tools therefore minimizing their effect on the study findings

1.11 Definition of Terms

Gender: In this study it refers to the influence of being male or female on choice of soil management technologies for maize production.

Land Degradation: Deterioration in the quality of land, its topsoil, vegetation, and/or water resources, caused usually by excessive or inappropriate exploitation.

Social perspectives: This is the behaviour that either women or men have that has an effect of soil management

Soil management: This concerns all operations, practices, and treatments used to protect soil and enhance its performance:

Soil Fertility Management Technologies: A set of soil fertility management practices that enhances improved food production.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers literature on gender and social perspectives influencing the adoption of soil management technologies. The literature was from books, journals, theses and reports.

2.2 Soil Management Technologies

Improving soil fertility management among smallholder farmers is widely recognized as a critical aspect in addressing food insecurity and poverty, especially in Sub-Saharan Africa, where up to 90% of the population in most countries earns their livelihood as smallholder farmers (Donovan & Casey, 1998; Freeman & Omiti, 2003). Sustained soil fertility management has been an important factor in increasing productivity, but this has been a challenge to Sub-Saharan Africa where on average, the rate of input intensity is estimated at between 8-12 kg ha-1 compared to over 83 kg ha-1 for all developing countries (Mwangi, 1997).

Due to many compelling reasons, which manifest themselves in increasing the relative cost of inorganic fertilizers, a number of traditional low-cost soil fertility management options have emerged, especially targeted at smallholder farmers (Ajayi, & Kwesiga, 2003). In Malawi, over the last six agricultural seasons, government policy has seemingly been promoting the integration of inorganic fertilizers and grain legumes within the traditional maize-based farming systems. This has been seen, for example, through the distribution of inorganic fertilizer and grain legume seeds through the Targeted Inputs

Programme (TIP) implemented since 1998 (Donovan & Casey, 1998). Promotion of integrated soil fertility management stems from the realization that smallholder farmers do not have the capacity to apply either option in optimal quantities. Besides, there are obvious disadvantages associated with either option when used independently, even in the less likely event of farmers being able to apply optimal quantities (Freeman & Omiti, 2003).

Despite government support, research results still indicate dismal adoption of the options that have been developed (Kumwenda *et al.,* 1995). One attributing factor is that the technical feasibility of such options is not consistent with the actual farm conditions. Moreover, the development process of the options has not adequately incorporated socio-economic and livelihood conditions which are at the core of farmers' decision-making. As such, effective policy support in soil fertility management requires knowledge of the factors that compel farmers to arrive at the choices they make. Thus, the objective of this study is to evaluate gender and social perspective in choice of soil fertility management technologies for maize production.

This study focused on integrated soil fertility management options involving inorganic fertilizer and grain legumes, but more especially the former, because whether or not farmers adopt the low-cost soil fertility options, significant yield effects are obtained with application of inorganic fertilizers. Thus inorganic fertilizer is still the key input that would increase the incentive for adoption of other options because even the biological nitrogen fixation function associated with grain legumes is greatly reduced when some nutrients are deficient. In this study, gender was considered to have an influence on choice of soil management technologies that influence maize production in the study area.

2.3 Encouraging Low-External Input Soil Fertility Management

Declining soil fertility, climatic extremes, high costs of inputs and lack of support for diversified income sources are all critical problems and are widely recognized as major factors responsible for declining agricultural productivity and increasing rural poverty (UNEP, 2009). Conventional farming practices such as intensive tillage and burning or removing crop residue often make these problems worse (Shetto, & Owenya, 2007). Attaining food security and development goals at the household and national levels requires a shift from conventional to more efficient, sustainable and climate resilient food production practices (FAO, 2010). Sustainable land management including conservation agriculture (CA) holds that promise (ACT, 2008).

Conservation agriculture, a three-pronged approach to farming, involving maintenance of permanent soil cover, practicing non-tillage planting methods to reduce soil disturbance, and implementing crop rotations/associations that break pest cycles and introduce nitrogen-fixing leguminous species to help restore soil fertility has shown potential for mitigating and adapting to impacts of climate change (Shetto, & Owenya 2007). Employing CA principles significantly increases and stabilizes crop yields while at the same time preserves the natural resources that are critical for food production (ACT, 2008).

Extensive use of organic fertilizers to overcome declining of soil fertility on smallholder farms in Kenya is consistent with the reality of low utilisation of inorganic fertilisers (Gachengo *et al.* 1999). According to Jama *et al.,* (1999), improved fallows are economical and have high returns to labour. Biomass transfer and improved fallow systems can therefore be as effective in supplying nitrogen, phosphorous, and potassium to maize as commercial fertilisers are. Jama *et al.* (1999) further established that these systems were profitable in terms of return to land and capital. These are interesting findings, given that small-scale farming systems in Kenya are characterised by high population densities, that 40 per cent of households are female-headed, and that land parcels are less than 0.8 hectares. However, these technologies need to be analysed for gender sensitivity and efforts made to make them more gender responsive.

The technical and financial performance of biomass transfer and improved fallow systems varies across spatial locations and across the gender divide. Due to poverty and pressure to fulfil daily household chores, women tend to prioritize short-term practical strategies rather than those demanded by some soil fertility management technologies (Flintan 2003). This often conflicts directly with conservation and environmental objectives that are more long-term in nature. There is a need, therefore, to evaluate the feasibility of different soil fertility management technologies and their acceptability in the different spatial, gender and socio-economic conditions of maize farmers in Kabiyet Division, Kenya.

Soil fertility degradation has been described as the single most important constraint to food security in Sub-Saharan Africa (SSA). Soil fertility decline is not just a problem of nutrient deficiency. It is a problem of soil physical and biological degradation, inappropriate crop varieties and cropping system design, of interactions with pests and diseases. The problem relates the linkage between poverty and land degradation, often perverse national and global policies with respect to incentives, and institutional failures (Boivin, et al, 2009).

Food security in Africa continues to be one of the most pressing problems facing governments and development agencies. While the rest of the world has seen significant increases in per capita food availability over the past 45 years, the situation in SSA has only improved slightly (FAO, 2008). Elsewhere in the world productivity gains through intensification of agriculture have largely been responsible for eliminating hunger.

Tackling soil fertility issues requires a long-term perspective and holistic approach of the kind embodied in the concept of Integrated Natural Resource Management (INRM). Soil fertility problems cannot be isolated from other development problems. Soil fertility degradation is linked with a number of social and environmental problems. For example, malnutrition is a major factor in over 54% of all deaths of children under 5 worldwide (Pelletier, 1994). The proportion is higher in Sub-Saharan Africa (SSA). Most of these deaths are not due to famine, with 83% of them attributable to mild-to-moderate malnutrition (Boivin et al., 2009).

The impact of soil fertility degradation is devastating for Africa’s environment and compromises future development opportunities. Land and soil degradation have serious consequences for other natural resources upon which Africa’s development depends. For example, degradation of water quality in rivers and lakes due to increased sediment loads affects fisheries and the quality of water sources for humans and animals. Lake Victoria, Africa's largest lake, has suffered a serious decline in water quality over the past 50 years due to increased sediment and nutrient loading. This has promoted the growth of the invasive water hyacinth plant, at great economic costs to the surrounding countries (Boivin et al., 2009).

According to Boivin*et al,* (2009), Soil fertility decline is associated with a number of simultaneous degradation processes that feedback on one another to produce a downward spiral in productivity and environmental quality. For example, as forest is cleared and put into low-input crop production, litter inputs are inevitably reduced. At the same time, tillage and other soil disturbance accelerates decomposition of soil organic matter. These two factors result in the decline of soil organic matter, which not only directly reduces retention of essential plant nutrients, but also results in breakdown in soil physical structure, which, in turn, reduces water infiltration and storage capacity in the soil. Low input levels of nutrient and organic matter and poor crop management contribute to poor crop growth, leaving the soil exposed to wind and water erosion. Finer soil particles, which contain most of the organic matter and nutrients, are then easily mobilized and transported by wind and water erosion to other parts of the landscape and into waterways, where they cause environmental damage. Large and costly inputs are then required to rehabilitate degraded soils and reverse the environmental damage. Preventing these processes is cheaper than trying to find a cure for the damage they cause.

Human-induced soil degradation is the most fundamental natural resource management problem threatening Africa's development. Water (46% of area) and wind erosion (38%) are the most important processes, but soil chemical (12%) and physical (4% degradation) are also important (Oldeman, 1994). Chemical soil degradation includes loss of nutrients, salinization, pollution, and acidification. Soil fertility degradation, including soil organic matter depletion, in smallholder farms affects 200 million hectares of cultivated land in 37 Africa countries and is becoming increasingly recognized as a primary constraint to agricultural development (Sanchez & Jama, 2002). However, as pointed out above, these degradation processes are usually closely inter-linked and must be managed in an integrated way. The large variation in soil fertility in African landscapes with the highest variability often being at the smallest scales (within farms) poses additional challenges to diagnosing constraints and recommending improvements.

2.4 Advances in Soil Fertility Management Innovations

A number of significant advances have been made over the past decade in the science and practice of soil fertility management in Africa. Soil fertility degradation takes place over a long time and recuperation of soil quality can be equally slow (Sanchez, & Jama, 2002). Therefore, lasting impacts of improved management require long-term investment of time and resources. But the impacts of improved management on crop yields are often dramatic even in the short term. Significant achievements from agricultural research have been demonstrated in improved livelihoods based on the development of soil management principles and in methodological approaches to address the major causes of poverty. The integration of other scientific disciplines, including ecology, economics and participatory social science, has helped formulate a more holistic approach to soil fertility management. Inability to objectively assess the spatial variation in soil quality and soil degradation has been a major constraint to solving soil degradation problems and managing soil fertility on a large scale. The application of approaches developed by landscape ecologists using new remote sensing and Geographic Information System tools has led to major breakthroughs in this area and was instrumental in problem diagnosis and lead to better targeted interventions (UNEP, 2009).

The impact of recommendations for soil management practices has been enhanced by the emergence of a consensus on guiding principles for Integrated Soil Fertility Management (ISFM). In essence, ISFM is the adoption of a holistic approach to research on soil fertility that embraces the full range of driving factors and consequences of soil degradation biological, physical, chemical, social, economic and political (FAO, 2008).

2.4.1 Improved Problem Assessment on Soil Degradation

Soil degradation is a 21st century global problem that is especially severe in the tropics and sub-tropics. Some estimates indicate degradation decreased soil ecosystem services by 60% between 1950 and 2010 (Leon, & Osorio, 2014). Accelerated soil degradation has reportedly affected as much as 500 million hectare in the tropics (Lamb, Erskine, & Parrotta, 2005) and globally 33% of earth's land surface is affected by some type of soil degradation (Bini, 2009). In addition to negatively impacting agronomic production, soil degradation can also dampen economic growth, especially in countries where agriculture is the engine for economic development (Scherr, 2001). Over and above the environmental and economic impacts, there are also health risks of soil erosion (Guerra, *et al.,* 2005) and other degradation processes (Lal, 2009).

Previous efforts to assess the extent and severity of soil degradation at national, continental and global levels have been based on expert opinion and lack of sufficient scientific validity to permit comparisons over space and time. More rigorous quantification is needed for targeting land and water management investments and decision-making on policies (Guerra, *et al.,* 2005).

Improving soil fertility management in African farming systems has therefore become a major development policy issue (Scoones and Toulmin, 1999; NEPAD, 2003). In a continent-wide survey to identify cases of success in African agriculture, techniques for soil fertility enhancement were most prominently mentioned (Gabre-Madhin & Haggblade, 2004).

2.4.2 Land Degradation Surveillance

FAO (2015) in its International Year of Soil noted that increasing degree and extent of soil degradation processes threatened the survival of human race. The problem of soil degradation highlighted by Sjors (2001) and Mwaura (2010) has placed a limit on the productivity of agriculture especially maize production. Many studies have been conducted globally to establish the relationship between agricultural land use and land degradation (Palmer-Felgate *et al.,* 2009; IFPRI, 2007; Pender *et al.,* 2004). Tukur *et al.* (2004) and Ogunleye *et al.,* (2004) did their studies in Africa and also concluded that there was a positive correlation between the two variables. Matsa and Muringania (2011) and Tiffen *et al.* (1994) conducted their research in Kenya and confirmed the same.

Surveillance is the ongoing systematic collection, collation, analysis and interpretation of data and dissemination of the information to stakeholders for action. Surveillance is fundamental for prevention and control of land degradation problems (Luise *et al.,* 2007). Key objectives of this approach include to estimate the extent of a soil degradation problem and to provide early warning of soil degradation 'outbreaks'. Others are to: monitor soil degradation trends, identify management risk factors, monitor progress towards achieving control objectives, evaluate interventions and preventive programmes, and identify research needs (FAO, 2012).

As Young (1998) noted, "the present unsatisfactory position in knowledge of soil degradation can only be overcome by measurement of changes in soil properties over time. Soil monitoring should become one of the basic activities of soil survey organizations. It is manifestly desirable for governments to know which land use practices maintain soil fertility and which degrade it". Like in medical surveillance, the two primary objectives for soil monitoring are pragmatic; to provide information that can be used to guide resource allocation, and for making land management decisions; and to develop an understanding of cause-and-effect relationships that could subsequently be used for prevention, early detection and outcome management of soil degradation.

Most previous assessments of soil degradation have not achieved this degree of rigour. Once the problem is measurable, then its prevalence (number of cases per unit area) can be assessed. From measurement of degradation prevalence it is possible to identify putative (tentative) risk factors, which are the keys to managing the problem. These, however, can only be confirmed by measuring the incidence (number of new cases per unit area per unit time) through monitoring programmes (prospective studies). Surveillance systems should be action-orientated, realistic and timely. Screening tests for rapid and accurate diagnosis of cases is a cornerstone of any surveillance programme. For instance, in modern disease surveillance there is very large investment in standard laboratory methods and laboratory confirmation of priority diseases. Apart from the general lack of case definitions for soil degradation, conventional soil laboratory tests are time consuming and expensive, making it impractical to adequately sample spatial variability. As a result, assessments of large areas are rarely attempted.

A major breakthrough has been the development of infrared spectroscopy, a laboratory-based screening tool for soil condition. Using the technology can be used to diagnose crop and livestock nutritional constraints, so that national laboratories can serve multiple purposes with one instrument without use of chemicals. Infrared spectroscopy allows for large numbers of geo-referenced soil samples to be rapidly characterized. It can therefore be used with in conjunction with satellite imagery to interpolate ground measurements over large areas. Recent developments in GIS and remote sensing have, at the same time, greatly increased capability for digital soil mapping (McBratney, 2003).

The fertility capability classification (Sanchez *et al.,* 2003) provides a useful framework for assessing soil fertility constraints in the tropics. Developments are underway to provide new soil fertility classification systems based directly on infrared spectral libraries of soils (Brown *et al.,* 2005; Shepherd *et al.* 2002). Since many soil problems are often strongly inter-related, emphasis on an integrated approach to assessing soil degradation is encouraged. The surveillance approach seeks a quantitative understanding of how soil functional capacity is affected by natural processes in the landscape and how human action affects this capacity through mediation of these processes.

New concepts of ecosystem resilience permit systems to evolve from one state to another, provided that key ecological functions, or services, are maintained. Managing ecosystems in a way that maintains their resilience requires an understanding of the interactive effects of the drivers of ecosystem dynamics and threshold effects in these dynamics that result in undesirable changes that are difficult to reverse. Because of our imperfect knowledge of ecosystem behaviour, this understanding can only be built up through purposive experimentation and observation adaptive management (Gunderson & Pritchard, 2002). There has also been much progress in concepts and research methods for trees, crops and soil fertility research (Schroth and Sinclair 2003), sustainable management of soil organic matter (Rees *et al.,* 2001), modelling below-ground interactions (Noordwijk *et al.,* 2004), and the application of these concepts to integrated plant nutrient management (Soil Science Society of America, 2001; Vanlauwe *et al.*,2002).

2.5 Improved Practices for Better Management at the Field Level

Significant adoption of a range of improved technologies has been documented across a number of countries in SSA. The technologies include soil and water conservation structures, such as 'zai' pits in the Sahel, organic nutrient management systems such as high quality manuring in intensive dairy systems in Kenya, and more integrated soil management practices. Available evidence shows that the technologies increase productivity in the environments where they have been adopted. But it is also known that what may work in one site, may not work in another due to differences in soil types, acidity levels, organic matter content, chemical composition of soils, rainfall, slope of land and other factors.

The most common practices applied include use of micro-doses of fertilizers, use of organic nitrogen sources (Mafongoya *et al.,* 1997), use of intercrop system, Biomass transfer or mulching with green-leaf manure using foliage of trees and shrubs cut and carried to cropping areas, use of green manure sources, Conservation agriculture which involves a number of approaches for reducing tillage, which results in higher retention of soil organic matter and improved physical properties of soil, such as water holding capacity, aggregation and infiltration. In addition to minimum or zero tillage, conservation agriculture involves early land preparation and timely planting, legume rotations, micro-water basins, point seeding and fertilizer application, and covering the soil with biomass.

International agricultural research has significantly contributed to the development of sound soil management principles that aim at sustainable crop production without compromising the ecosystem service functions of soil. These include: Application of organic resources of animal or plant origin in combination with mineral inputs to maximize input use efficiencies and increase returns to investments, integration of cover crop and multi-purpose, woody and herbaceous legumes into cropping systems to increase the availability of organic resources and consequently increase crop yields and farm profits, enhancing the soil organic carbon pool as an integrator of various soil-based functions related to production and ecosystem services, improved sustainability of nutrient cycles through integration of livestock with arable production and Soil conservation methods to control soil loss and improve water capture and use efficiency (Louis *et al.,* 2007).

Mineral fertilizers can quickly replenish lost plant nutrients but their continued application without organic matter inputs can lead to declining yields because of other problems such as imbalance or deficiency of certain nutrients, deterioration in soil structure and acidification of the soil. Some studies have found high economic returns to the use of organic nutrients, such as green manures in Kenya (Kipsat *et al.,* 2004), and farmyard manure in Zimbabwe (Mutiro & Murwira, 2004). However, studies conducted in different parts of SSA show that integration of inorganic and organic nutrient inputs is a better option to increasing fertilizer use efficiency and providing a more balanced supply of nutrients (Gachengo *et al.,* 1999 and Nziguheba *et al.,* 2004).

Organic and inorganic inputs cannot be substituted entirely by one another and are both required for sustainable crop production (Vanlauwe *et al.* 2002a; Sanchez and Jama 2002; Place *et al.* 2003). Studies in Kenya and Uganda report a higher maize yield when organic and inorganic inputs are combined than when either of them is applied separately (Jama *et al.,* 2000; Delve, 2004).

2.6 Socio-Economic and Policy Issues Affecting Soil Management

Overall, one major contribution of the past and current ISFM initiatives is the enhanced understanding and insights, by practitioners, of other agricultural disciplinary issues and how ISFM is related to these and other factors influencing livelihoods in smallholder farming communities (Abunyewa, & Mercer-Quarshie, 2004). It is the socio-economic and policy components of ISFM research that have generally lagged behind and more attention is required to integrate them with current advances in biophysical research. Understanding the reasons why farmers have not widely adopted many ISFM technologies falls under these disciplines (Giller, 2013).

Best-bet technologies that include grain-legume rotations and intercropping, green manures, animal manures, mineral fertilizers, combinations of inorganic and organic nutrient sources, and agroforestry-based technologies have been developed. Definition of best-bet technologies was based on the following criteria (Waddington *et al.* 1998); Long-term contributions to increased soil fertility, appropriateness for many farmers across important agro-ecologies, small additional cash and/or labour requirements, appropriateness in areas with little competition for arable land, resulting ease of adoption by farmers, only a small reduction in maize yields or substitution by production of other crops and compatibility with other components of the farming systems. However, most of these technologies have been tested at plot-level and, therefore, views about their suitability may reflect how well these technologies link to other integrative elements at the farm scale. The only comprehensive evaluation of best-bet technologies on a nationwide scale was done in Malawi by the Maize Productivity Task Force (Gilbert *et al.* 2002), but analysis was not based on the set criteria for best bets. Recent synthesis work suggests that the limited technology evaluation studies done were conducted in isolation.

Phiri *et al*. (2005) reported of fragmented and unpublished studies related to the adoption of soil fertility technologies in Zambia. Many players promoting soil fertility were often located in different areas of the country and pursued different operational objectives with different resource bases. Limited and isolated testing was also done in Zimbabwe and Mozambique. It is therefore apparent that despite sound and development-oriented criteria, little or no analysis has been done to verify the conformity of the various technologies to the set criteria.

According to Rusike *et al.* (2005) national governments of Malawi, Mozambique, Zambia and Zimbabwe have adopted a common set of agricultural development priorities and now have similar policies that are supportive of ISFM as they endeavour to modernise their smallholder agricultural sector (liberalization of input/output markets, adoption of demand driven research and development). This presents an opportunity for a regional approach to ISFM technology development and dissemination, scaling up and impact assessment, in order to promote systems innovation. There is high social differentiation in adoption and intensity of adoption of ISFM technologies. Most of the adopters are relatively wealthy and experienced farmers who are also active members of extension groups, mostly located in high rainfall areas (Phiri *et al.* 2005). These findings suggest that a minimum threshold of resource endowment is necessary for a farmer to adopt, the technologies and implies a greater developmental challenge for breaking the vicious cycle of poverty.

2.7 Farmers' Choice of Soil Fertility Management Technologies

A review of the literature on adoption of both inorganic and organic soil fertility management inputs among smallholder farmers in Malawi reveals very low and inconsistent uptake rates (Kumwenda *et al.* 1995; Minot *et al.* 2000). With the disruption of hybrid maize and fertilizer uptake, which occurred in the late 1980s and early 1990s, fertilizer use on maize has been continuously low. Both demand and supply constraints have contributed towards the low fertilizer uptake and have reinforced a spiral of low agronomic productivity, which results in reduced effective input demand. The situation has also been aggravated by the stagnant aggregate fertilizer supply and less effective distribution mechanisms.

From the demand side, the major factor that depresses fertilizer uptake is the increase in the domestic fertilizer price relative to output price. Because all fertilizers in Malawi are imported, domestic prices are invariably sensitive to devaluation. The effect has been further compounded because Malawi depreciated its foreign exchange regime at roughly the same time when the country's agricultural policy seriously embarked on full liberalization of the input and output market, which necessitated the removal of input subsidies. Supply side constraints point to structural problems related to importation due to the country's land-locked position. The bulk of smallholder fertilizer is still handled through the parastatal institutions: Smallholder Farmers Fertilizer Revolving Fund of Malawi (SFFRFM) and Agricultural Development and Marketing Cooperation (ADMARC), because even though the market is liberalized, private traders are few and often find it difficult to gain an increasing share of the market due to the poor state of development of the rural infrastructure (Kherallah & Govindan 1999; Ng'ong'ola *et al,.* 1997). As such, the input retail price is substantially higher thus making the product highly unaffordable by the majority of the smallholder farmers. Relatively low maize: nitrogen price ratios have been experienced since the 1990s because even though both the maize and fertilizer markets are deregulated, the rate at which fertilizer price increases is higher relative to that of maize.

Apart from the price related variables, socio-economic variables such as wealth status, human and physical capital endowment, institutional support and location specificity for example access to markets (product, input and capital), are some key variables that largely explain the choice of soil fertility management options (Green & Ng'ong'ola 1993; Minot *et al.* 2000).

Most empirical studies on adoption of agricultural technologies such as Mureithi *et al.* (2000), Mulugeta (2001) and Ransom *et al.,* (2003) concentrate on farmers' characteristics as the main factors that influence adoption or rejection of agricultural technology's package. They compare farmers who have adopted or rejected a certain technology at a point in time against their own socio-economic characteristics. This study evaluated gender and social perspectives that influenced that choice of soil management technologies for maize production in Nandi County. Farmers tend to adopt technologies whose returns are high relative to their traditional alternatives. That is technologies whose relative profitability is high compared with their traditional alternatives. They also choose to adopt technologies with relatively low risks as compared to their traditional alternatives (Cheryll *et al.,* 2000). Barret (2001) in Ethiopia observed that, farmers continue to loose in terms of crop yields despite introduction of new agricultural technologies since the cost of fertilizers and improved seeds continue to be high. He further said that, if the technology is not cost -reducing, the farmers are not likely to adopt it in future seasons to come, unless policy options such as provision of credit facilities are effected.

2.8 Factors Influencing the Adoption of Soil Fertility Management Technologies for Maize Production

A study on factors influencing adoption by Ransom et al. (2003) on the hills of Nepal revealed that, a significant and positive relationship exists between years of use of fertilizer, off-farm income, contact with extension and adoption. Researches on agricultural innovations show that, farmers‟ different personal characteristics lead some to adopt innovations more readily than others (KARI, 2002). It appears that, future growth in maize production in Kenya would have to depend mainly on yield gains, made possible by widespread use of technologies that promote maize production such as use of improved germplasm contained in hybrid maize varieties available in the Kenyan seed market (KARI, 2002).

The FAO has recognized that, globally, "Gender inequalities in land rights are pervasive. Not only do women have lower access to land than men. They are often also restricted to so called secondary land rights, meaning that they hold these rights through male family members. Women thus risk losing entitlements in case of divorce, widowhood or their husband's migration. Evidence also shows that women's land parcels are generally of smaller size and lower quality" than men's (FAO, 2010). Single women or those whose marriages are not formally recognized also typically have more tenuous rights to land. While women's land and property rights are vital to development, the reality remains that in many parts of the world these rights are often not shared equally between men and women, and are routinely violated, denied, and given insufficient protection and enforcement. The obstacles which prevent women from effectively enjoying these rights equally with men are complex, and at times context specific. They range from inadequate legal standards and implementation of laws, to discriminatory social norms, attitudes, and programs at the national, regional and local levels which taken together result in wide discrepancies in practice between development outcomes for men and women (Gomez & Tran, 2012).

Conley and Udry (2003) model on the adoption of pineapple production practices in Ghana found that social learning is important in the spread of the new technologies. Foster and Rosezweig (1995) find that own experience and neighbor's experiences with high yielding varieties in India significantly increased the profitability from these varieties. Considerable more work is needed in this area to understand how the use of technologies spread.

Gender specialists have demonstrated that whether a farmer is a man or a woman is not, in and of itself, the most important factor affecting adoption of agricultural technologies (Doss, 1999). Controlling for farmers' access to productive resources, wealth, education, or marital status may eliminate gender differences in adoption rates, also modulating gender differences in adoption impacts. For example, Doss and Morris (2001) demonstrated that gender-linked differences in the rates of adoption of modern maize varieties and chemical fertilizer in Ghana resulted from gender-linked differences in access to complementary inputs such as land, labor, extension and market extension services. Quisumbing and Pandolfelli (2009) noted that few studies have examined socio-economic differences among women when analyzing decision-making, such as technology adoption.

A study of Macharia *et al*., (2010) examined the profitability of soil fertility and management practices in small-scale maize-based production systems in the Central Province of Kenya. The researchers found that the household head was the main decision-maker in households they interviewed, deciding which crops to grow, which soil and fertility management practices to use, when to obtain a loan, and the strategic direction of development on the farm. Male-headed households differed from female-headed households in terms of their initiatives and innovations. As has been repeatedly demonstrated in Kenya, the education household heads was a critical factor in the choice of development initiatives, which new farming techniques they adopted, and the changes made in farming enterprises. The authors noted, however, that wives generally decided on the maize varieties grown.

In their analysis of fertilizer use on maize in Zambia, Ricker-Gilbert, Jayne, and Chirwa (2011) found that the gender of the household head had no effect on maize yields, although hybrid seed use, nitrogen use, use of animal or mechanical power were important factors. Also in Zambia, Kimhi (2006) found a negative relationship between female headship and area allocated to maize as well as maize yields, when controlling for a smaller maize plot sizes. In a sample of households interviewed in selected districts of major maize-producing zones, Langyintuo and Mungoma (2008) found that gender of household had no effect on either the likelihood of hybrid use or the area share allocated to hybrid seed. The lack of statistical significance held across households when they were grouped by wealth index into poorly- and well-endowed segments. Salasya *et al*. (2007) evaluated the factors influencing the adoption of stress-tolerant maize in Western Kenya, finding that the dummy for gender of household head was not statistically significant in the probit equation. In the Coastal Lowlands of Kenya, Wekesa *et al.* (2003) also found that the gender of the household head was of no significance in the decision to grow maize hybrids. Ouma *et al* (2002) found that gender was a significant determinant of adoption if hybrid seed and basal fertilizer in Embu District in Kenya. So were, however, manure use, hiring of labor, and extension where all of which are likely to be associated with gender of household head. Other variables, such as age and education of household head, farm size, credit and education were not found to be statistically significant.

Much empirical adoption literature focuses on farm size as the first and probably the most important determinant (*Daku, 2002;* Nkonya *et al,* 1997; and Doss and Morris, 2001). A study by Gabre-Madhin and Haggblade*,* (2001) found that large commercial farmers adopted new high-yielding maize varieties more rapidly than small farm holders. Koundouri *et al, (*2002) argue that farmers' decision to adopt a new technology is affected by risk factors which are related to production risk and how the new technology can change the amount of production and profitability of the farmers. Particularly, farmers with poor farming practices and use of traditional agricultural appliances are afraid of taking risks to adopt new ways of farming practices. Kosarek *et al.,* (2001) also found that farmers' decision to adopt hybrid maize was determined by the expected returns (profitability) of the technology, the availability of hybrid seed, and risks associated with the expected outcomes of the new technology.

Factors like the total land area and the total number of animals will affect farm household's production decisions of rice. The study showed that the animal asset and the percentage of rice areas have the largest impact on a household's profit (Yan Liang, 2006). According to Kassie *et al,* (2009) adoption decisions can also be significantly influenced by land rights and the future security of tenure among farmers. The rapid adoption of GMHT crops were explained by the economic benefits results from higher yields or reduced costs, production efficiency and flexibility and simplification of conservation tillage (Dill *et al.,* 2008).

Doss, (2007) also stated that; it is useful to collect information whether or not farmers have ever used improved technologies before in order to understand and introduce new technologies. In addition, Koundouri *et al,* (2006) also wrote that farmer's information about the new technology plays a significant role in deciding to adopt the improved agricultural technology. The extent to which farmers learn from each other and the influence of social network can also play a vital role in accepting and disseminating new technologies to a large population. The main source of information for farmers is other farmers because information is easily available and it is not too costly to utilize it (Gershon *et al, 2004*). This is confirmed by a survey data which showed that farmers cite other farmers as their main source of information regarding agricultural practices (Rees *et al,* 2000).

Age is an important factor that influences the probability of adoption of new technologies because it is said to be a primary latent characteristic in adoption decisions. However, there is contention on the direction of the effect of age on adoption. Age was found to positively influence adoption of sorghum in Burkina Faso (Adesiina & Baidu-Forson, 1995), IPM on peanuts in Georgia (McNamara *et al*, 1991), and chemical control of rice stink bug in Texas (Harper *et al*, 1990). In contrast, age has been found to be either negatively correlated with adoption, or not significant in farmers' adoption decisions. In studies on adoption of land conservation practices in Niger (Baidu-Forson, 1999), rice in Guinea (Adesiina & Baidu-Forson, 1995), fertilizer in Malawi IPM sweep nets in Texas (Harper *et al*, 1990), Hybrid Cocoa in Ghana (Boahene *et al*, 1999), age was either not significant or was negatively related to adoption.

Gender issues in agricultural production and technology adoption have been investigated for a long time. Most of such studies show mixed evidence regarding the different roles men and women play in technology adoption. Doss and Morris (2001) in their study on factors influencing improved maize technology adoption in Ghana, and Overfield and Fleming (2001) studying coffee production in Papua New Guinea show insignificant effects of gender on adoption.

Furthermore, access to funds including credit is expected to increase the probability of adoption. For instance, it has been reported that most small scale farmers in the country are unable to afford basic production technologies such as fertilisers and other agrochemicals resulting in low crop yields due to poverty and limited access to credit (Ministry of Food and Agriculture, Ghana, 2010). This study investigated the socio-economic factors influencing the choice of technologies in maize production systems in Kabiyet Division, Nandi County, Kenya.

2.9 Strategies for Enhancing soil Fertility for Maize Production

The agriculture sector and the issue of soil fertility management in the developing world remain torn between the roles of stakeholders on the best practices and farmers. Sub-Saharan Africa's rapid population growth, combined with a stagnating agricultural productivity, has led to a decrease in per capita food production. It is now the only region in the world where both the number and the proportion of malnourished children has been consistently rising in recent years (FAO, 2010).

There are no long-term studies monitoring the status of soils, nutrient balances and crop Productivity for improved livelihoods in most countries such as Kenya. However, evidence from various sources indicate that soil fertility is declining as demonstrated by studies on farmers' perceptions of soil fertility change, nutrient balances and on-station fertilizer trails (Rubaihayo 2006; Wortmann, et al, 2006). In Uganda, the National Agricultural Research Organization (NARO) (2007) observed, that improving Integrated Soil Fertility Management (ISFM) has been given little consideration in agricultural policies and planning, largely because it is commonly believed that Ugandan soils are very fertile (Zake, 2002). Despite the contributions of the agricultural sector, agricultural development remains a challenge in developing countries with little attention to the challenges facing agricultural sector. There has been a notable decline in food production due limited use of artificial fertilizers, increase in poverty levels (Keith, 2008).

Worldwide, most extension agents have, in fact, had broader impacts than merely transferring technology (Keith, 2008). Thus, increasing agricultural productivity not only relies on improved production efficiencies, such as through adoption of modern or improved technologies and practices, but also critically relies on crop rotation and intercropping. Farmers in different environment can increase their farm productivity more than what they actually produce when they link between knowledge and action in crop rotation and intercropping. Crop rotation is also used, though not as soil management technology but rather unexpectedly (Ssekabembe, 2005).

Integrated soil fertility management (ISFM) is a means to increase crop productivity in a profitable and environmentally friendly way (Vanlauwe *et al.,* 2010) and thus to eliminate one of the main factors that perpetuates rural poverty and natural resource degradation in Sub-Saharan Africa (SSA). Current interest in ISFM partly results from widespread demonstration of the benefits of typical ISFM interventions at plot scale, including the combined use of organic manure and mineral fertilizers (Zingore *et al.,* 2008), dual-purpose legume–cereal rotations (Sanginga *et al.,* 2003), or micro-dosing of fertilizer and manure for cereals in semi-arid areas (Tabo *et al.,* 2007). ISFM is also aligned to the principles of sustainable intensification (Pretty *et al.,* 2011; Vanlauwe *et al.,* 2014), one of the paradigms guiding initiatives to increase the productivity of smallholder farming systems. Sustainable intensification, though lacking a universally accepted definition, usually comprises aspects of enhanced crop productivity, maintenance and/or restoration of other ecosystems services, and enhanced resilience to shocks. ISFM can increase crop productivity and likely enhances other ecosystems services and resilience by diversifying farming systems, mainly with legumes, and increasing the availability of organic resources within farms, mainly as crop residues and/or farmyard manure. This study investigated strategies employed by farmers in enhancing soil fertility management technologies in Kabiyet Division, Nandi County.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the research methodology that was used for data collection, analysis and presentation. It presents the research design, sample frame, sampling procedures, methods of data collection and data analysis. In conducting this study, both primary and secondary data was used, while qualitative and quantitative techniques were used in data analysis.

3.2 Research Design

This study adopted a descriptive survey design. This design is appropriate for data collection in large areas. According to Aggarwal (2008) descriptive research is devoted to the gathering of information about prevailing conditions or situations for the purpose of description and interpretation. A descriptive design was selected because of its high degree of representativeness and the ease in which a researcher could obtain the participants' opinion (Polit & Beck 2004). The researcher obtained and described the views of the respondents with regard to the gender and social perspectives in choice of soil fertility management technologies for maize production.

3.3 Sampling Frame

The sampling frame was drawn from 6,505 households in the division as shown in Table 3.1.

Table 3.1: Households in Kabiyet Division

Location	Household numbers	Sub-Location	Household Numbers	Sample size
Kabiyet	1947	Cheptuiyet	293	30
Kamasia	854	Kamasia	127	13
Lolkeringet	1854	Chemnoet	289	29
Kebulonik	1850	Rubet	277	28
Total	6,505		986	100

3.4 Sampling Techniques and Sample Size

The sampling technique used in this study was multi-stage cluster sampling. The division was taken as a cluster with six locations and 18 sub-locations. The locations have three sub-locations while others have two or four sub-locations. One sub-location in each sub-cluster (location) was selected by simple random sampling technique. Ten percent (10%) of households in each sub-location were selected by simple random sampling technique as per the population proportion where the first household was picked by simple random sampling technique followed systematic random sampling where every 10^{th} household was selected. The choice of 10% was based on recommendations by Mugenda and Mugenda (2003). A total of 100 households were selected in the study giving 1.5 percent of the total population. Neuman (2000) argues that for large populations small sampling ratios (1 percent) are possible and can be very accurate and therefore 1.5 percent of the population was considered adequate.

3.5 Sources of Data

Both primary and secondary data was obtained for the study. Interviews, questionnaire administration and observations comprised the main sources of primary data, obtained directly from randomly selected households. Secondary data was obtained from review of published and unpublished materials from books, refereed journal articles, unpublished theses and dissertations.

3.6 Data Collection Instruments

The instruments used for collection of data relevant to this study were interview schedules, questionnaires and observations.

3.6.1 Interview Schedules

This technique was used to gather information from the household members regarding gender and social perspectives in choice of soil fertility management technologies for maize production in Kabiyet Division. Interview schedule was utilized to obtain detailed information from the Sub County Agricultural Officer.

3.6.2 Questionnaire

Questionnaires were administered to 100 respondents. The questionnaire consisted of both structured and non-structured questions. The unstructured items captured opinion, feeling and suggestions of the respondents in the space provided. All the questions in the questionnaire related to the objectives and the research questions. According to Orodho (2003), a questionnaire has more advantages because it allows the collection within a short period of time. It also helps to ensure that all respondents reply to the same set of questions and that answers are in the words of the respondents and thus free from bias. The questionnaires comprised of both open and closed-ended questions. The closed-ended items were suitable as they limited the responses. The advantage of this is that only relevant responses which are easy to analyze and compare are obtained.

3.6.3 Observation

Direct observation was used to observe soil fertility management technologies that have been adopted by maize farmers in the division. This technique helps to eliminate subjective bias from questionnaire and interview. However, this method has its limitations. In observation method, information observed is limited and sometimes unforeseen factors may interfere with the observational task (Kothari, 2004).

3.7 Methods of Data Analysis and Presentation

The study utilized descriptive methods of data analysis. This entailed the use of measures of central tendencies such as frequencies and percentages. Quantitative data was analyzed using frequencies and percentages while qualitative data was summarized and interpreted in line with the research objectives and questions. Results of data analysis were presented in form of Figures and Tables.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter documents the findings that emerged from the data analysis of questionnaires and interview schedules on the evaluation of gender and social perspectives in choice of soil fertility management technologies for maize production in Nandi County. The chapter is divided into two sections, with section one, dealing with the demographic description of participants involved in the study. The second section addresses the objectives of the study as; effects of social and gender diversities in the soil management practices that enhance maize production, the gender roles that influence the choice of soil fertility management technologies in maize production, the socio-economic characteristics that influence the choice of technologies in maize production systems and the strategies used by farmers in enhancing soil fertility management technologies.

4.2 Basic Description of the Respondents

Among the basic information sought in this study were; sex, age bracket, farm size, fertilizers and chemicals (herbicides) used. This was in order for the researcher to understand the effects of these variables on choice of soil fertility management technologies for maize production.

4.2.1 Gender of the Respondents

From the study it was found out that 71% of the household heads were male while 29% household heads were female as shown in Figure 4.1.

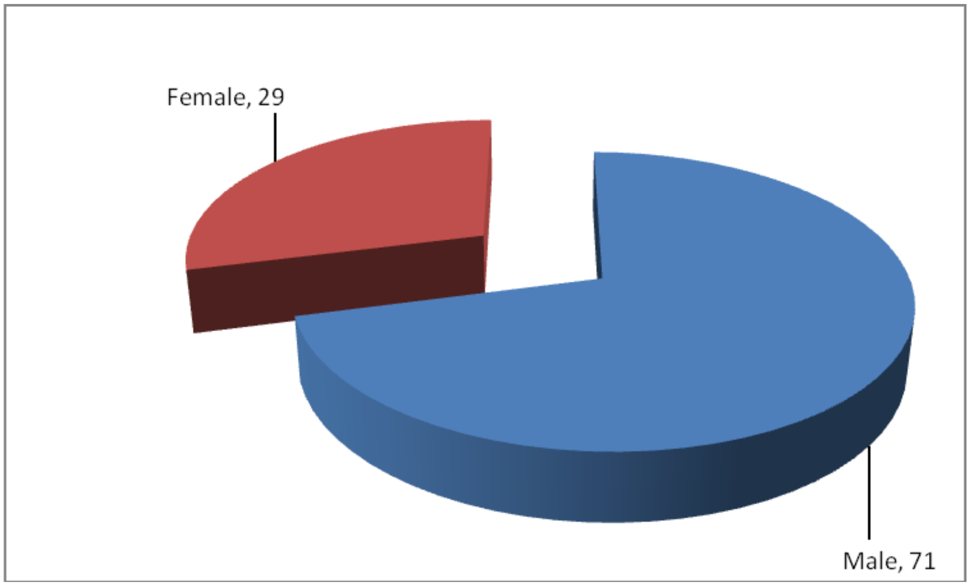

Figure 4.1: Gender of Respondents

The study findings showed that male headed households dominate maize farming in Kabiyet division. In this region men are the landowners and take almost all decisions. Women on the other hand have user rights to the land and bear the bulk of the agricultural and domestic work. According to the World Bank report (2013), women make up 80% of Kenya's farmers. However, despite their majority, they still have many challenges to overcome, like gaining ownership of the land they work on. Further, Mignouna *et al*. (2011) on their study on determinants of adopting imazapyr-resistant maize technologies and its impact on household income in western Kenya found out that the gender of the household head is hypothesized to relate positively to the adoption of an IRM package. The assumption is that the head of the household is the primary decision maker and men have more access and control over vital production resources than women due to many socio-cultural values and norms.

4.2.2 Age Bracket of the Respondents

Further, it emerged that 45.0% of the farmers were aged 40-49 years, 24% were aged 30-39 years, 24% were aged over 50 years while 7% of the farmers were aged 20-29 years as shown in Figure 4.2.

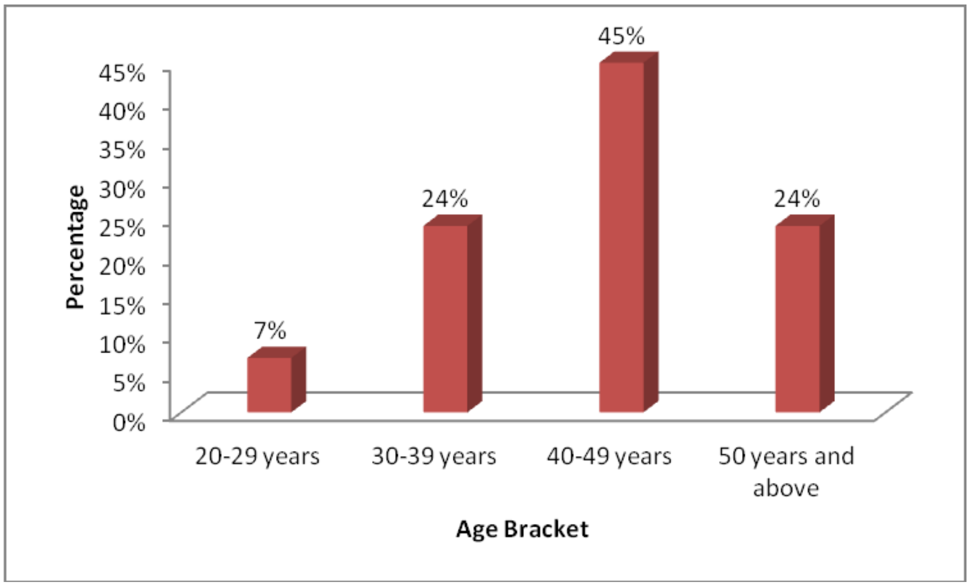

Figure 4.2: Age Bracket of the Respondents

The findings showed that most of the maize farmers in Kabiyet Division were aged between 40 and 49 years. This implies that they had been in the farming business for longer periods of time and were able to adopt soil fertility management technologies that enhanced maize production. According to Nepal and Thapa (2009) at the younger age, farmers may not be able to adopt modern agricultural production technologies, especially capital intensive ones because of the fact that they might not have adequate resources to do so.

4.2.3 Household Farm Size

The size of the farms could be an influencing factor for soil conservation technologies that enhances maize production. The respondents were therefore asked to indicate the size of their farms. The results showed that 66.0% of the farmers had less than 5 acres, 18.0% of the farmers had 6-10acres, 10% of the farmers had 10 -15 acres while 6% of the farmers had over 16 acres of land as shown in Figure 4.3.

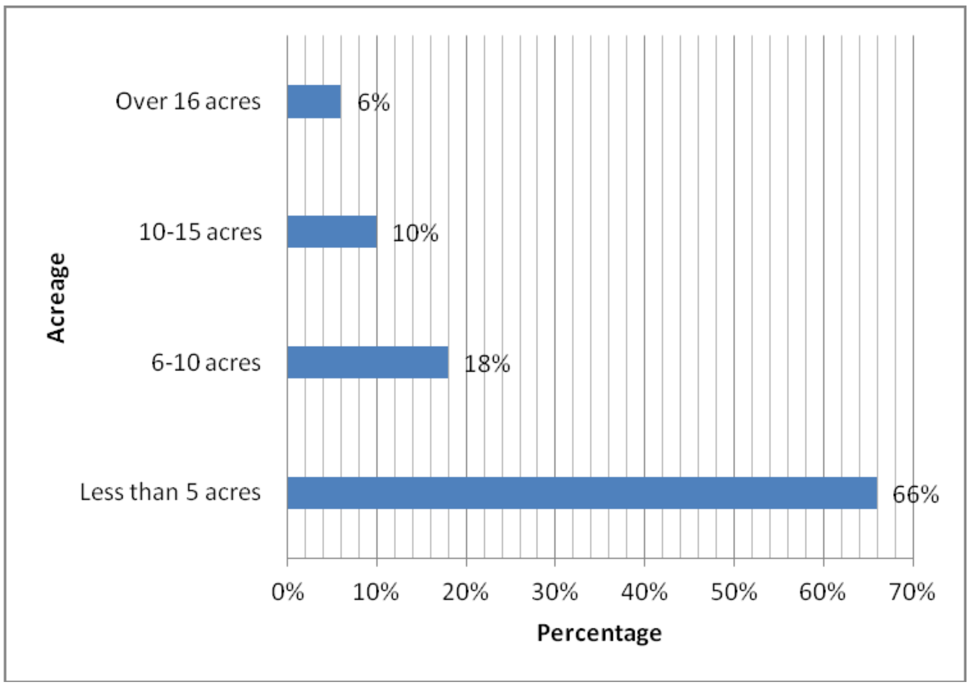

Figure 4.3: Household Land Acreage

The study findings showed that a majority (66.0%) of the households in Kabiyet Division had less than 5 acres of land. This implies that most of the maize farmers in Kabiyet division are small scale farmers and this could influence the adoption of maize production technologies. According to Barrett *et al.* (2005), the relationship between technology adoption and agricultural productivity is, complex as it is influenced and shaped by farm and farmer characteristics and farm size, among other factors. In this study the small sizes of farms could negatively impact on the adoption of maize production technologies. In addition, the increase in population has led to land fragmentation in the study area where most household had less than 5 acres. This concurs with Mugwe *et al.,* (2009) who found that in central Kenya increased population had led to land fragmentations where most farm sizes ranged between 0.5 ha and 1 ha per household. However, a study by Ndiema *et al.,* (2002) in Njoro showed no significant relationship between adoption of agricultural technologies and farm size.

4.2.4 Fertilizer Use

The study findings showed that all the households used fertilizers for maize production. However, it emerged that 89% of the farmers were using inorganic fertilizers as compared to 11% of the farmers who used organic fertilizers for maize production as presented in Figure 4.4.

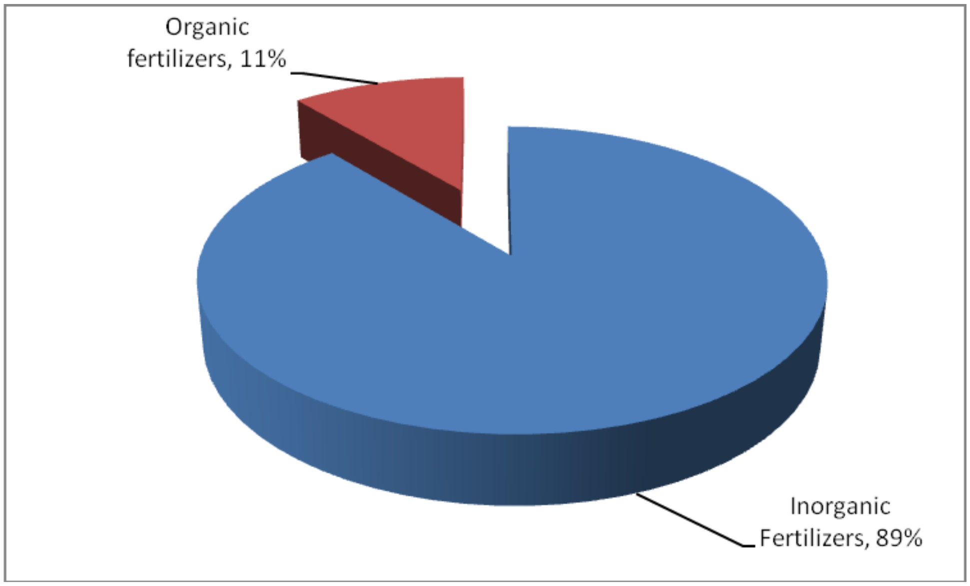

Figure 4.4: Household Fertilizer use

From the Figure 4, it can be shown that majority of the farmers in the division usually use inorganic fertilizer to increase maize production in their farms. Reduced soil fertility in the study area due to continuous cropping has led to increased use of fertilizers to replenish soil nutrient depletion. In a study by Mugwe *et al.* (2009) most smallholder farmers in Central Kenya used mineral fertilizers and cattle manure for crop production. Fertilizers are able to increase crop yields and additionally produce enough residues for soil fertility management, while organic sources are able to rehabilitate less responsive soils and make them responsive to fertilizers (Vanlauwe *et al.* 2010).

4.2.5 Use of Herbicides

The respondents were further asked to indicate whether they used herbicides in their farms or not. The results are presented in Table 4.1.

Table 4.1: Use of Herbicides

Response	Frequency	Percent
No	46	48.4
Yes	49	51.6
Total	95	100.0

Table 4.1 shows that 51.6% respondents used various forms of herbicides in their farms while 48.4% respondents did not use any herbicides in their farms. The study findings showed that most of the farmers in the division were using herbicides in maize production. However, the use of herbicides is still low as compared to other parts of the country. This concurs with Okoboi, et al, (2012) who found that use of herbicides/fungicides, in maize production in Uganda was low. In most cases farmers usually use family labour in maize production.

4.3 Social Diversities in the Soil Management Technologies in Maize Production

Social diversity issues are specific and are evident in virtually every aspect of life including the farming of maize, and all processes of production and processing (Kaitano, 2009). This study sought to evaluate the effects of social diversities in the soil management technologies that enhance maize production in Kabiyet Division, Nandi County. The respondents were asked to indicate their responses on available soil management technologies in the study area in the questionnaire. However, respondents indicated more than two responses since most farmers used more than one strategy making this a multiple response. The study findings are presented in Table 4.2.

Table 4.2: Soil Management Technologies

Soil management technologies	Frequency	Percentage
Terracing	113	22.5
Crop Rotation	67	13.4
Mulching	33	6.6
Nutrient management	69	13.8
Intercropping	128	25.5
Minimum/Zero tillage	33	6.6
Use of cover crops	59	11.8
TOTAL	**502**	**100.0**

Source: Field Data, 2015 (multiple Response)

Table 4.2 shows that 25.5% of the farmers used intercropping as a soil management strategy, 22.5% respondents were using terracing as a soil management strategy, 13.8% respondents were using nutrient management as a soil management strategy while 13.4% respondents were using crop rotation as a soil management strategy. In addition, 11.8%, 6.6% and 6.6% respondents were using cover crops, mulching and minimum/zero tillage respectively as soil management strategies. The study findings showed that intercropping and terracing were the most commonly used soil management strategies that enhanced maize production in Kabiyet Division. The farmers intercropped mostly maize and beans. Intercropping of cereals and legumes would be valuable because the component crops can utilize different sources of nitrogen, which is scarce in most soils. The cereal may be more competitive than the legume for soil mineral Nitrogen, but the legume can fix nitrogen symbiotically if effective strains of Rhizobium are present in the soil. This implies that use of terracing could reduce soil erosion and enhance maize productivity in the region.

Nutrient management was also considered a factor in enhancing maize productivity in Kabiyet division. Nutrient management in this case involved soil testing to understand the nutrient requirements of the soils in the study area. This will enable the control of rate and type of fertilizer application for maize production. The importance of a regular soil testing program has long been recognized by most maize farmers. The goals of soil is to determine existing levels of available soil nutrients and recommend fertilizer applications to prevent any nutrient deficiency which may hinder crop production. Proper soil testing gives a relative index of soil supplied nutrients and nutrients previously supplied from manure, legume crops or commercial fertilizer.

In addition, the farmers were requested to indicate in the questionnaire where they acquired the technologies used in maize production. Multiple responses were allowed in this question since some farmers could have acquired the technologies from more than one source. The responses were tabulated and the results are presented in Table 4.3.

Table 4.3: Acquisition of Soil Management Technologies

Responses	**Frequencies**	**Percentages**
Field days	97	27.2
Agricultural extension officers	147	41.2
Media	25	7.0
other farmers	36	10.1
Training	31	8.7
Field trips	21	5.9
Total	**357**	**100.0**

Source: Field Data, 2015 (Multiple Response)

Table 4.3 shows that 41.2% of the respondents reported they acquired Soil Management Technologies from agricultural extension officers, 27.2% respondents acquired through field days, 10.1% of the respondents acquired through farmers, 8.7% respondents acquired the technologies from trainings they attended. In addition, 7.0% and 5.9% respondents acquired the technologies from the media and farmers' field trips respectively.

This implies that most of the farmers acquired soil management technologies from agricultural extension officers and field days organized by these officers. Since extension is a process of getting useful information to farmers to help them acquire knowledge, skills and change of attitude and to implement this information effectively; agricultural extension officers therefore, should be competent in using variety of teaching methods as a tool in training farmers

4.3.1 Social Groups Involved in Acquisition of Farm Technologies

In addition, the respondents were asked to indicate the social groups that were more involved in the acquisition and use of farm technologies. The results are presented in Table 4.4.

Table 4.4: Social Group More Involved in the Acquisition and Use of the Farm Technologies

Social Group	Frequency	Percent
The youth	41	43.2
Women	8	8.4
Men	44	46.3
The Elderly	2	2.1
Total	**95**	**100.0**

Source: Field Data, 2015

On social groups that are more involved in the acquisition and use of the farm technologies, it emerged that 46.3% of the respondents reported men were more involved in the acquisition and use of the farm technologies, 43.2% of the respondents reported that the youths were more involved in the acquisition and use of the farm technologies, 8.4% of the respondents cited that women were more involved in the acquisition and use of the farm technologies while 2.1% respondents reported that family members were involved in the acquisition and use of the farm technologies.

On interviewing the Sub-County Agriculture Officer (SCAO), it emerged that most of the activities on maize production were done by the youth and the women, but the decision-makers were men. The results are not perfectly realized because this group of women and the youth were not financially empowered and had no knowledge on soil management technologies. The SCAO noted that most farmers acquired soil management technologies through agricultural extension officers who are stationed in each ward and the field days and demonstrations organized in households and institutions within the study area.

4.4 Gender Roles that Influence the Choice of Soil Fertility Management Technologies in Maize production

The respondents were asked to indicate in the questionnaire the persons who owned land they were tilling. The results of data analysis are presented in Table 4.5.

Table 4.5: Persons Owning Land for Maize Production

Land Owner	Frequency	Percentages
Men	61	64.2
Women	9	9.5
Government	2	2.1
Community	1	1.1
Leased	22	23.1
Total	**95**	**100**

Source: Field Data, 2015

From the Table 4.5, it was found out that 64.2% of the respondents reported that men owned land that they were tilling, 9.5% respondents cited that women were the owners of land and 3.1% respondents indicated that they were tiling leased land while 2.1% respondents cited that they were tilling government land. From the responses, it emerged that majority of the respondents at 64.2% cited that men were the owners of land. This implies that women are disadvantaged in land ownership and therefore any decisions made on soil fertility management technologies for maize production tends to be made by men.

In addition, the respondents were asked to indicate the persons responsible for making decisions specifically on technologies used in maize production. The results of data analysis are presented in Table 4.6.

Table 4.6: Group Responsible for Decision Making in Technology Adoption

Group Responsible for Decision Making	Frequency	Percentages
Men	67	70.5
Women	10	10.5
Youth	5	5.3
Government	13	13.7
Total	**95**	**100.0**

Source: Field Data, 2016

Table 4.6 shows that 70.5% of the respondents reported that men were responsible for making decisions concerning technology adoption for maize production, 13.7% of the respondents reported that the government made decisions on technologies used in maize production and 10.5% respondents reported that women were responsible for making decisions on maize production technologies while 5.3% respondents cited that the youths were responsible for making decisions on maize production technologies. From the responses, it emerged that majority (70.5%) of the respondents believed that men were responsible for making any decision on the adoption of maize production technologies.

Further, the respondents were asked to indicate the persons who made decisions specifically on technologies used in maize production. The results are presented in Figure 4.5.

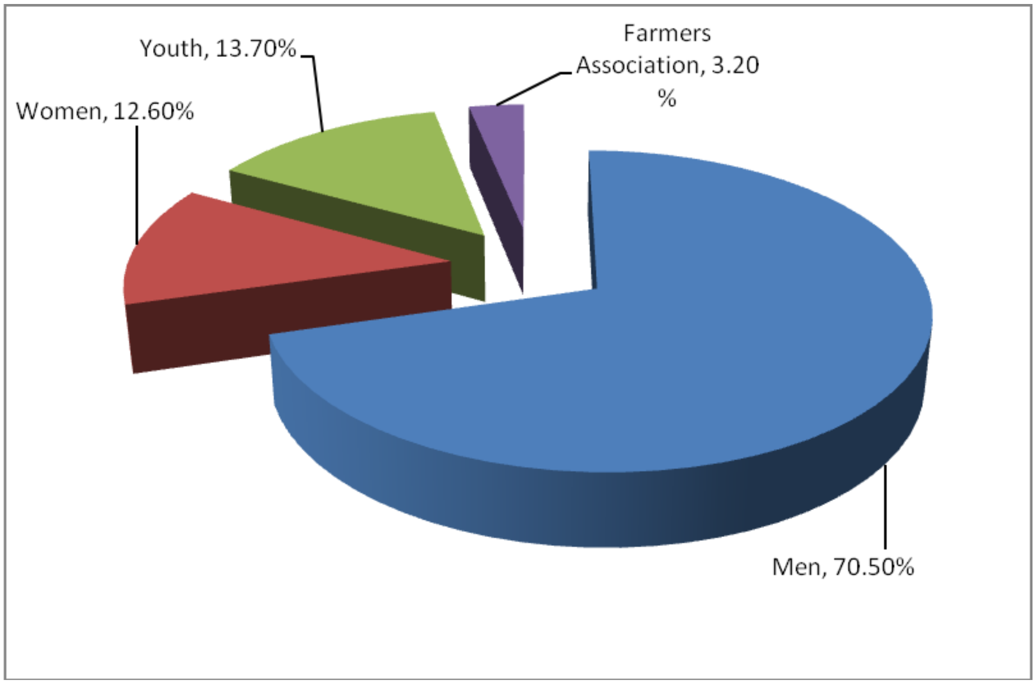

Figure 4.5: Decision Makers in Technologies Used in Maize Production

Figure 4.5 shows that 70.5 percent respondents reported that men were the decision makers on the implementation of maize production technologies, 12.6 percent of respondents cited that women were the decision makers as far as maize production technologies were concerned and 13.7 percent of respondents believed that the youth were the decision makers on the implementation of maize production technologies while 3.2% of the respondents reported that farmers' associations were the decision makers on implementation of maize production technologies. The study findings showed that majority of the respondents (70.5%) believed that men were the decision makers in the implementation of maize production technologies. This is consistent with World Bank, (2000) which showed that women have less contact with extension services than men and generally use lower levels of technology because of problems of access and cultural restrictions.

On interviewing the SCAO, it emerged that men were the major decision makers on acquisition on farm inputs and soil fertility management practices on maize production. However, the implementers of these technologies were mostly the youth and women. This implies that women and youth have low or no influence on the acquisition of soil management technologies for maize production in the study area.

4.5 Socio-Economic Characteristics that Influence the Choice of Technologies in Maize Production Systems

The study further sought to evaluate the socio-economic characteristics that influence the choice of technologies in maize production systems in Kabiyet Division. The respondents were requested to indicate the persons who did actual tilling of land for maize production. The results are presented in Table 4.7.

Table 4.7: Persons Responsible for Land Tilling for Maize Cultivation

Persons	Frequency	Percent
Men	44	46.3
Women	13	13.7
Youth	27	28.4
Others	11	11.6
Total	**95**	**100.0**

Source: Field Data, 2015

Table 4.7 shows that 46.3% of the respondents indicated that men were responsible for the tilling of land for maize production. However, 28.4% of the youths also contributed a larger percentage for those responsible for land tillage followed by women at 13.7%. This implies that men and youth contribute a larger percentage of labour for land tillage in maize production. This pointed out that women have access to land but are not so much involved in tilling for maize production purposes.

Further, it emerged that 67.4% of the respondents reported that men were responsible for the costs incurred for technologies used in maize production while 1.1% reported that the government met the technology transfer costs. This implies that men were more involved in technology acquisition in maize production as compared to other groups as shown in Table 4.8.

Table 4.8: Groups who Meet Costs Associated with Technology Acquisition in Maize Production

Group	Frequency	Percent
Men	64	67.4
Women	22	23.2
Youth	8	8.4
Government	1	1.1
Total	**95**	**100.0**

Source: Field Data, 2015

This shows that men are the dominant group in Technology adoption for maize production in the study area.

In addition, the respondents were asked to rate their level of agreement on a five point likert scale items in the questionnaire on socio-economic characteristics that influence the adoption of technologies associated with maize production. The items were scored and their means tabulated. The results are presented in Table 4.9.

Table 4.9: Socio-Economic Characteristics that Influence the Choice of Technologies in Maize Production Systems

Socio-economic characteristic	Mean	Std. Deviation
Primary occupation of the farmers	4.5	.80
Annual income of the farmers	4.3	.91
Household size of the farmers	2.6	1.32
Membership of farmers' group of the farmers	2.8	1.24
Educational attainment of the farmers	3.4	1.42
Age of the farmers	3.0	1.67
Farm size of the farmers	3.8	1.42
Availability of credit facilities enables farmers to easily acquire agricultural technologies	3.5	1.46
Participation in agricultural project activities enables farmers to easily acquire agricultural technologies	4.2	1.04

Source: Field Data, 2015

Table 4.9 shows that household size, membership of farmers' group and age of the farmer had insignificant influence the adoption of agricultural technologies for maize production. These factors were found to had a mean of less than 3.0. However, primary occupation of the farmers, annual income, educational attainment, farm size, availability of credit facilities and participation in agricultural project activities were considered by the farmers to be the factors that influence the adoption of agricultural technologies for maize production. These factors had a mean of over 3.5. Primary occupation, annual income and farmers' participation in agricultural project activities were found to be the prime factors influencing the adoption of soil fertility management technologies for maize production in Nandi County. This is consistent with Nepal and Thapa, (2009) who argued that at the younger age, farmers may not be able to adopt modern agricultural production technologies, especially capital intensive ones because of the fact that they might not have adequate resources to do so. Further, it concurs with Gabre-Madhin and Haggblade, (2001) who found out that large commercial farmers adopted new high-yielding maize varieties more rapidly than small farm holders. The study finding further supports and earlier research by Friis-Hansen and Duveskog (2012) which found out that income had a positive and significant relationship with adoption of agricultural technologies.

On interviewing the SCAO, it was found out that women and youth were vulnerable because they did not have finance to acquire the required input and soil fertility management technologies to enhance maize production thus affecting productivity of maize and management of soil in the study area. It further emerged from the interview that culturally most men were the main land owners and therefore women and youth had low access to land hence minimum modification on the soil fertility management technologies.

4.6 Strategies used by Farmers in Enhancing Soil Fertility Management Technologies

Soil fertility is seen as declining as demonstrated by studies on farmers' perceptions of soil fertility change, nutrient balances and on-station fertilizer trails (Rubaihayo 2006; Wortmann, Lubanga and Kaizzi 2006). Maize farmers were asked to indicate whether they had undergone any training in soil management technologies. The results are presented in Figure 4.6.

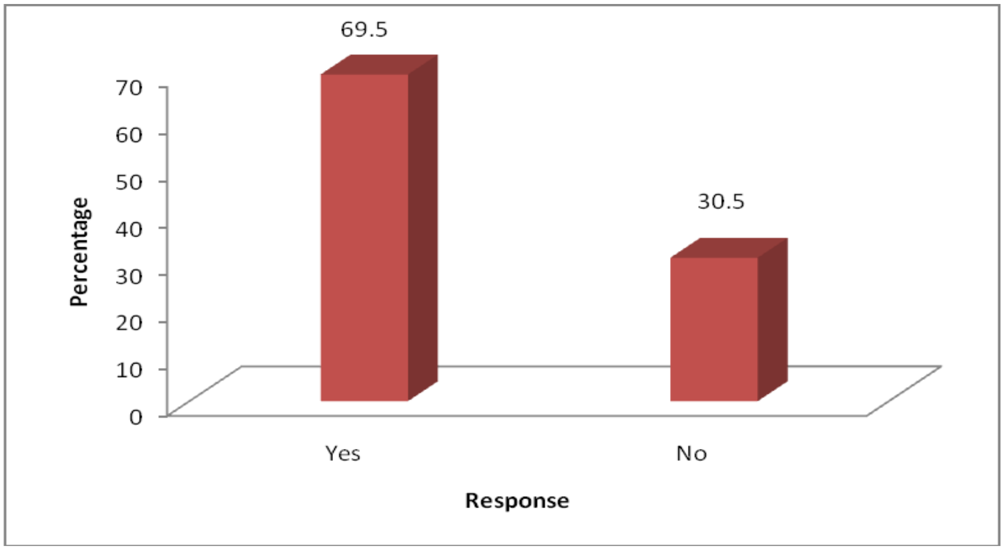

Figure 4.6: Farmers' Response on Attendance of Training in Soil Management Technologies

Figure 4.6 shows that 69.5% of the farmers in the study area had underwent training on soil management strategies while 30.5% of the farmers had not undergone any training on soil management strategies. This implies that majority of the farmers at 69.5% were able to develop various strategies aimed at conserving soil for better maize production.

For the farmers who had attended training, they were asked to indicate the form of training they had undergone. The results are presented in Table 4.10.

Table 4.10: Form of Training Undergone by Maize Farmers

Form of Training	**Frequency**	**Percent**
Workshops	7	10.6
Seminars	16	24.2
Farmers field Day	28	42.4
Agricultural tours	11	16.7
Others	4	6.1
Total	**66**	**100.0**

Source: Field Data, 2015

Table 4.10 shows that most farmers at 42.4% had undergone trainings on soil management technologies through farmers' field days. This was followed by seminars (24.2%), agricultural tours (16.7%) and workshops (10.6%) among others respectively. The results showed that information could easily be passed to farmers by holding farmers' field days. The Farmer Field School (FFS) is a participatory approach that uses non-formal adult education methods based on experimental/discovery learning techniques and participatory training. Initiating farmers' field days will also improve on the adoption of various technologies for better agricultural productivity.

In addition, the respondents were requested to indicate their level of agreement on a five point likert scale items on strategies used by farmers in enhancing soil fertility management technologies. The results are presented in Table 4.11.

Table 4.11: Strategies used by Farmers in Enhancing Soil Fertility Management Technologies

Strategy	Mean	Std. Deviation
Use of inorganic fertilizers	3.9	1.40
Use of organic fertilizers	4.0	1.34
use of crop rotational programme	4.0	1.09
Use of zero tillage	3.1	1.40
Mixed cropping	4.4	.82
Improved land tenure systems	3.8	1.28
Improved fallows	3.7	1.23
Use of contour ridging	3.9	1.26
Encouraging early planting	4.2	1.27
Use of mulching in crop production	3.9	1.28
Understanding soil characteristics through regular use of soil sampling and analysis	4.3	1.11

Source: Field Data, 2015

Table 4.11 among the common strategies that were mostly used by farmers were understanding soil characteristics through regular use of soil sampling and analysis, mixed cropping and early planting while the least used technologies was use of zero tillage. This depended on several factors which are associated with the farmer characteristics, availability of technologies and the cost of technologies adopted. Soil sampling and analysis helps farmers in determining the rate and types of fertilizers to be applied.

On interviewing the SCAO, it was realized that maize farmers in the study area should be sensitized on soil fertility management technologies through barazas, farmers' field schools, trainings and field days for easy acquisition and implementation of soil technologies to enhance maize production and income for food security and better living in the division

CHAPTER FIVE

DISCUSSIONS

5.1 Introduction

This chapter discusses the findings of the study undertaken on gender and social perspective in choice of soil fertility management technologies for maize production in Kabiyet division, Nandi County. The discussion follows the objectives of the study.

5.2 Social Diversities in the Soil Management Practices in Maize Production

Gender issues are area specific and are evident in virtually every aspect of life including the farming of maize, and all processes of production and processing (Kaitano, 2009). This study sought to evaluate the effects of social and gender diversities in the soil management practices that enhance maize production in Kabiyet Division, Nandi County. The study findings suggested that intercropping and terracing were the most commonly used soil management strategies that enhanced maize production in Kabiyet Division. It has been found that intercropping has been successful as compared to monocroping in enhancing crop productivity for example in Sub-Saharan Africa Several scientists such as Egbe, (2010); Mucheru-Muna *et al*., (2010); Obadoni *et al.,* (2010); Addo-Quaye *et al.,* (2011); Okoth and Siameto, (2011) and Osman et al., (2011) working with cereal-legume intercropping systems have proved its success compared to the monocrops.

The farmers indicated that they intercropped mostly maize and beans. According to Chu *et al.,* (2004), intercropping of cereals and legumes would be valuable because the component crops can utilize different sources of Nitrogen, which is scarce in most soils.

The cereal may be more competitive than the legume for soil mineral N, but the legume can fix N symbiotically if effective strains of Rhizobium are present in the soil. Further terracing was rated as the second most used type of soil management strategy in Kabiyet division. Zuazo *et al.,* (2005) reported that terraces are successful soil erosion control manner in regions endangered by soil erosion by combinations of steep slopes, climatic conditions and erodible soils. This implies that use of terracing could reduce soil erosion and enhance maize productivity in the region.

On acquisition of soil management technologies, it emerged therefore that most of the farmers acquired soil management technologies from agricultural extension officers and field days organized by these officers. Since extension is a process of getting useful information to farmers to help them acquire knowledge, skills and change of attitude and to implement this information effectively; agricultural extension officers therefore, should be competent in using variety of teaching methods as a tool in training farmers (Tiraieyari *et al.,* 2010). Okunade (2007) contended that extension agents must have adequate knowledge of the characteristics of each of the extension teaching methods as well as know the characteristics of the farmers in the process of technology transfer.

This study findings concurs with those of Adolwa *et al.,* (2010), Matata *et al.,* (2008) and Bationo *et al.,* (2004) who reported that in order to create awareness on Integrated soil fertility management (ISFM) practices, dissemination of knowledge and information should be done through regular trainings using workshops, demonstrations, seminars, field days and short exchange visits. Training overcomes constraints through providing appropriate knowledge and new skills (Wegulo *et al.,* 2009) and thus providing an understanding of what a technology entails and facilitates its efficient adoption and utilization.

On social groups that are more involved in the acquisition and use of the farm technologies, it emerged that men and youths were more involved than women in the acquisition and use of the farm technologies. However, most studies done show that membership to social group influences positively the acquisition of agricultural production technologies (Ajagbe, 2012; Wayo, 2002).

5.3 Gender Roles that Influence the Choice of Soil Fertility Management Technologies in Maize Production

The study further showed that women were disadvantaged in land ownership and therefore any decisions made on soil fertility management technologies for maize production tended to be made by men. This is consistent with the findings of Quisumbing, (1995) who reported that female farmers may have minimal access to land and own fewer tools and are less likely to adopt new technologies. Furthermore, Kassie *et al*, (2009) noted that technological adoption decisions can also be significantly influenced by land rights and the future security of tenure among farmers.

On decision makers in technologies used in maize production, the study findings showed that majority of the respondents (70.5%) believed that men were the decision makers in the implementation of maize production technologies. Adoption of maize production technologies is one important component within the innovation-decision process (Rogers, 1995). It seems therefore that decision making on maize production in Kabiyet Division is vested mostly on men. This supports the findings of Wekesa, et al.,(2003) who found out that generally decision-making was purely a man's responsibility in the Mijikenda community. However, there is some consultation among households members before final decisions are made. On the other hand, women (or any other responsible member of non-Mijikenda household) could make decisions in the absence of the man. In female-headed households women make all the decisions.

5.4 Socio-Economic Characteristics that Influence the Choice of Technologies in Maize Production Systems

The study further sought to evaluate the socio-economic characteristics that influence the choice of technologies in maize production systems in Kabiyet Division. The study found out that men and youth contribute a larger percentage of labour for land tillage in maize production. This pointed out that women have access to land but are not so much involved in tilling for maize production purposes. This is in line with Swiss Agency for Development and Cooperation (SDC) (2015) report which indicated that women had access but not control over new post-harvest technologies in maize production in Nakuru, Naivasha and Embu Districts. World Development Report (World Bank 2007), pointed out that farming is a key pathway out of poverty for women and that women's prospects for taking this path improve when they have better access to resources. Because of their limited access to essential production resources, such as land, labor, and inputs, women's role in crop agriculture is often restricted to producing subsistence food crops with low potential to generate income. The prospects for women to expand their incomes through alternatives such as seasonal migration or labor markets outside agriculture are limited. Women's mobility is usually more constrained by social and cultural norms, and women play a central role in raising and caring for children.

In addition, men were found to be the dominant group in Technology adoption for maize production in the study area. While technological implications of the different spheres of operation exist, logically, one can assume from these gender differences that the adoption, adaptation, allocation and utilization of the various technologies, are directly related to the different activities in the production cycle (Wekesa, *et al.,* 2003).

The study indicated that primary occupation, annual income and farmers' participation in agricultural project activities were found to be the prime factors influencing the adoption of soil fertility management technologies for maize production in Nandi County. Studies by Ouma *et al*., (2002) found out that variables such as age and education of household head, farm size, credit and education were not associated to adoption of agricultural technologies. However, Weir and Knight (2000) found out that, in Ethiopia, household-level education affects whether a farmer is an early or late adopter, but is less important in determining whether or not the farmer ever uses fertilizer.

The study finding supports an earlier research by Friis-Hansen and Duveskog (2012) which found out that income had a positive and significant relationship with adoption of agricultural technologies. Furthermore, Davis *et al.* (2012) showed that group members had no significantly higher crops yields than nonmembers in Uganda, while in both Kenya and Tanzania, group members had recorded significant higher yields and household incomes. This study showed that being a member of a particular agricultural group influenced the adoption of soil management technologies for maize production.

Further, Mwaura (2014) farmers who had access to extension and credit services reported higher yields of maize due to adoption of agricultural technologies.

5.5 Strategies Used by Farmers in Enhancing Soil Fertility Management Technologies

Soil fertility is declining as demonstrated by studies on farmers' perceptions of soil fertility change, nutrient balances and on-station fertilizer trails (Rubaihayo 2006; Wortmann, et al. 2006). In this study, it was found out that majority (69.5%) of the farmers were able to develop various strategies aimed at conserving soil for better maize production. Demeke (2003) reported farmers' access to training will increase the probability of retaining erosion-controlling structures.

Furthermore, farmers' field day was found to be the most used method by farmers in obtaining information on available technologies on soil management. The Farmer Field School (FFS) is a participatory approach that uses non-formal adult education methods based on experimental/discovery learning techniques and participatory training. Initiating farmers' field days will also improve on the adoption of various technologies for better agricultural productivity. According to Rogers (1995) the technology is passed from its source to the end users through a medium for example news media, opinion leaders, on-farm or on-station demonstrations, farmers' field days and its diffusion to potential users is dependent to a great extent on the personal attributes of the individual user.

Use of soil sampling and analysis, mixed cropping and early planting were the most commonly used strategies in enhancing soil fertility management technologies while the least used technologies was use of zero tillage. This depended on several factors which are associated with the farmer characteristics, availability of technologies and the cost of technologies adopted. Soil sampling and analysis helps farmers in determining the rate and types of fertilizers to be applied. Studies show that integration of inorganic and organic nutrient inputs is a better option to increasing fertilizer use efficiency and providing a more balanced supply of nutrients (Gachengo *et al.* 1999 and Nziguheba *et al.* 2004). This implies that use of fertilizers for maize production improves its productivity.

Crop rotation has been associated with the prevention of soil erosion as cited by Nepal and Thapa (2009), who found in his studies that farmers with larger farms were able to practice crop rotation hence prevent soil erosion. Further as a mitigation measure to soil depletion, according to Ochieng *et al.,* (2012) the Ministry of Agriculture through extension officers have been educating maize farmers on the importance of crop rotation. Crop rotations, reduced tillage, cover cropping, fallow periods, manuring and balanced fertilizer application can help maintain and restore soil fertility. This findings further supports those of Mafongoya *et al.,* (2005) who found out that the most common soil management practices applied in most countries in Sub-Saharan Africa include use of micro-doses of fertilizers, use of *organic nitrogen sources* and use of intercrop system.
On sloping land, anti-erosion measures are necessary to conserve the fertile topsoil and sustain long-term crop productivity. Without such measures, soils will degrade and become unproductive. One technique often promoted is progressive terracing using *Calliandra calothyrsus* hedgerows combined with earth embankments whereby the soil is deposited above a furrow dug along the contour. However, these measures often have

few short-term benefits and reduce the area available for cropping. In addition, hedgerows may compete with the crops, and earth embankments may bring up less fertile subsoil.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The chapter highlights the conclusions and recommendations of the study as per the four objectives of the study.

6.2 Conclusions

The study concluded that intercropping and terracing were the most commonly used soil management strategies that enhanced maize production in Kabiyet Division where maize and legumes (beans) were mostly intercropped. Terraces are successful soil erosion control manner in regions endangered by soil erosion by combinations of steep slopes, climatic conditions and erodible soils.

Most of the farmers acquired soil management technologies from agricultural extension officers and field days organized by these officers. Since extension is a process of getting useful information to farmers to help them acquire knowledge, skills and change of attitude and to implement this information effectively; agricultural extension officers therefore, should be competent in using variety of teaching methods as a tool in training.

On decision makers in technologies used in maize production, the study concluded that men were the decision makers in the implementation of maize production technologies. On social groups that are more involved in the acquisition and use of the farm technologies, it was concluded that men and youths were more involved than women in the acquisition and use of the farm technologies.

The study further concluded that men and youth contributed a larger percentage of labour for land tillage in maize production. This pointed out that women have access to land but are not so much involved in tilling for maize production purposes. In addition, men were found to be the dominant group in Technology adoption for maize production in the study area.

Farmers' Primary occupation, annual income and farmers' participation in agricultural project activities are the prime factors influencing the adoption of soil fertility management technologies for maize production in Nandi County.

Furthermore, farmers' field day was found to be the most used method by farmers in obtaining information on available technologies on soil management. Moreover, use of soil sampling and analysis, mixed cropping and early planting were the most commonly used strategies in enhancing soil fertility management technologies while the least used technologies were use of zero tillage. This depended on several factors which were associated with the farmer characteristics, availability of technologies and the cost of technologies adopted. Soil sampling and analysis helps farmers in determining the rate and types of fertilizers to be applied.

6.3 Recommendations

The following are the recommendations of this study;

Men were found to be the major decision makers in the implementation of maize production technologies. Therefore, there is need for the women and the youth to be more involved in the acquisition of soil management technologies for maize production.

There is need for agricultural field days to be organized by both the County and the National governments more frequently in the study area especially during the land preparation stages. This will enable maize farmers to obtain current soil management technologies such as conservation agriculture, zero tillage, use of varieties of herbicides and use of cover crops for maize production since only intercropping and terracing were the most commonly used technologies in the area.

Soil sampling equipment and soil analysis laboratories need to be availed to farmers in order for them understand soil nutrients in their farms which are important for maize crop. This will help farmers further in understanding rate and type of fertilizer use in their farms thus increasing maize production.

6.4 Suggestions for Further Studies

i. The researcher recommends that similar studies be carried out in other regions where farmers engage in maize production in the country to allow for the generalization of the study findings.
ii. There is need for a study on the effectiveness of the current soil management technologies in order to recommend to farmers an efficient technology which is cost effective.

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APPENDICES

APPENDIX I: RESEARCH QUESTIONNAIRE

I am Rose Kemmey a Masters student at University of Eldoret (School of Environmental Studies), as a requirement for partial fulfillment of the degree, am carrying out a research on: **"Evaluation of Gender and Social Perspectives in Choice of Soil Fertility Management Technologies for Maize Production Nandi County".**

I kindly request your assistance in filling this questionnaire as truthful as possible. Please tick in the brackets your right response [√], give a yes or no response where appropriate and brief explanation where necessary.

This research is intended strictly for academic purpose and nothing else. All information shall be treated with utmost confidentiality. Your cooperation was highly appreciated.

Thanks in advance

PART A: <u>PERSONAL DETAILS</u>

1. Sex; (i) Male ☐ (ii) Female ☐

2. Age bracket

   (i) 20-29 years ☐ (ii) 30-39 years ☐

   (iii) 40-49 years ☐ (iv) ≥ 50 years ☐

3. What is the size of your farm?

   (i) Less than 5 acres ☐ (ii) 6 – 10 acres ☐

   (iii) 10 – 15 acres ☐ (iv) Over 16 acres ☐

4. What type of fertilizer do you mostly use in planting your maize?

   (i) Inorganic Fertilizers ☐

   (ii) Organic Fertilizers ☐

   (iii) None ☐

5. (i) Do you use any herbicides or any other chemical in your farm?

   Yes ☐

   No ☐

(ii) If yes, indicate the type you mostly use

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Section B: Effects of social and gender diversities in the soil management practices that enhance maize production

1. What are the common soil management technologies used in enhancing maize production your area? (Multiple responses allowed)

(a) Terracing ☐ (b) Mulching ☐

(c) Crop rotation ☐ (d) Nutrient management ☐

(e) Intercropping ☐ (f) Use of cover crops ☐

(g) Minimum/zero tillage ☐

2. Where did you acquire the technologies used in maize production? (Multiple responses allowed).

(a) Field days ☐ (b) Agricultural extension officers ☐

(c) Media ☐ (d) other farmers ☐

(e) Training ☐ (e) Field trips ☐

3. Who makes the decision on implementation of the technologies?

(i) Men ☐ (ii) Women ☐ (iii) Youth ☐

(iv) Others (specify)……………………………………………………

4. In your opinion, which social group is more involved in the acquisition and use of the farm technologies?

(i) The youth ☐

(ii) Women ☐

(iii) Men ☐

(iv) Any other (specify) ……………………………………………………

Section C: Gender roles that influence the choice of soil fertility management technologies in maize production

1. Who owns the land?

(i) Husband ☐ (ii) Wife ☐

(iii) Father ☐ (iv) Government ☐

(v) Any other (specify)……………………………..

2. Who makes decisions specifically on technologies used in maize production?

(i) Men (ii) Women

(iii) Youth (iv) Any other (specify)…………………………………..

3. Who does the actual tilling of the land?

(i) Men ☐ (ii) Women ☐

(iii) Youth ☐ (iv) Any other (specify)…………………………………..

Section D: Socio-economic characteristics that influence the choice of technologies in maize production systems

1. On average what is the cost of tilling one acre of land for maize production?

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2. On the technologies, acquired, who meets the cost of the technologies used in maize production?

(i) Men ☐ (ii) women ☐

(iii) Youth ☐ (iv) Government ☐

(vi) NGOs ☐

(vii) Any other, (specify)_________________________________

3. Please indicate your level of agreement or disagreement of the following socio-economic characteristics that affect adoption of technologies for maize production

SD – Strongly Disagree D – Disagree; UD – Undecided; A – Agree, SA- Strongly Agree

Socio-economic characteristic	SD	D	UD	A	SA
Primary occupation of the farmers affects adoption of agricultural technologies					
Annual income of the farmers affects adoption of agricultural technologies					
Household size of the farmers affects adoption of agricultural technologies					
Membership of farmers' group of the farmers affects adoption of agricultural technologies					
Educational attainment of the farmers affects adoption of agricultural technologies					
Age of the farmers affects adoption of agricultural technologies					
Farm size of the farmers affects adoption of agricultural technologies					
Availability of credit facilities enables farmers to easily acquire agricultural technologies					
Participation in agricultural project activities enables farmers to easily acquire agricultural technologies					

Section E: Strategies used by farmers in enhancing soil fertility management technologies

1. (a) Have your undergone any training on soil management strategies

(i) Yes ☐ (ii) No ☐

(b) If yes, what form of training have you undergone?

(i) Workshops ☐ (ii) Seminars ☐

(iii) Farmers Field Days ☐ (iv) Agricultural Tours ☐

(v) Any other (Specify) ______________________________

(c) Indicate your level of agreement/disagreement on the following strategies to enhance soil management technologies.

Strategy	SD	D	UD	A	SA
Use of inorganic fertilizers					
Use of organic fertilizers					
Use of intercropping					
Use of crop rotational program					
Use of zero tillage					
mixed crop-livestock farming					
Improved Land tenure systems					
improved fallows					
Use of contour ridging					
Encouraging early planting					
Use of mulching in crop production					
Understanding soil characteristics through regular use of soil sampling and analysis					

APPENDIX II: INTERVIEW SCHEDULE FOR SCAO

1. What are the effects of social and gender diversities in the soil management practices that enhance maize production?

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2. What are the gender roles that influence the choice of soil fertility management technologies in maize production in Kabiyet division?

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3. What are the socio-economic characteristics that influence the choice of technologies in maize production systems in Kabiyet division?

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4. What strategies do farmers use in enhancing soil fertility management technologies?

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APPENDIX III: RESEARCH AUTHORIZATION LETTERS

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email:dg@nacosti.go.ke
Website: www.nacosti.go.ke
when replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No.
NACOSTI/P/16/89975/11830

Date:
15th June, 2016

Rose Jerotich Kemei
University of Eldoret
P.O. Box 1125-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Evaluation of gender and social perspectives in choice of soil fertility management technologies for maize production Nandi County,***" I am pleased to inform you that you have been authorized to undertake research in **Nandi County** for the period ending **13th June, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Nandi County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. STEPHEN K. KIBIRU, PhD.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nandi County.

The County Director of Education
Nandi County.

APPENDIX IV: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MISS. ROSE JEROTICH KEMEI
of UNIVERSITY OF ELDORET, 1125-30100
eldoret,has been permitted to conduct
research in *Uasin-Gishu* County

on the topic: *EVALUATION OF GENDER AND SOCIAL PERSPECTIVES IN CHOICE OF SOIL FERTILITY MANAGEMENT TECHNOLOGIES FOR MAIZE PRODUCTION NANDI COUNTY*

for the period ending:
13th June,2017

Permit No : NACOSTI/P/16/89975/11830
Date Of Issue : 15th June,2016
Fee Recieved :ksh 1000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 9541

CONDITIONS: see back page

APPENDIX V: MAP OF THE STUDY AREA