FARMERS' PERCEPTIONS OF THE IMPACT OF SOIL EROSION ON MAIZE PRODUCTION IN SOY DIVISION, ELGEIYO-MARAKWET COUNTY, KENYA

BY

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DECLARATION

Declaration by the candidate

This thesis is my original work and has not been presented in part or as a whole for any academic award in any university.

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ABSTRACT

Soil erosion is a major problem especially in arid and semi-arid areas of Kenya and cause significant effects to agricultural production particularly on rain fed cultivation. This study aimed to examine farmers' perception of the impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya. It was guided by the following specific objectives: to examine farmers' knowledge of soil erosion, to assess factors that influence soil erosion, to explore farmers' perceived impacts of soil erosion on maize production, and to assess soil erosion mitigation measures. The study was based on Marginal Zone Theory of Lewis Binford and Kent Flannery (2005). This study utilized descriptive survey design and used probability proportionate to size (PPS) random sampling technique and simple random sampling method. Secondary data was collected through review of materials including books, websites and published and unpublished reports. Primary data was sourced through questionnaires and interview schedules administered to a sample size of 135 subjects out of a target population of 5993 heads of households and informants through face-to-face interviews that included government officials, NGOs and CBOs, and chiefs who were selected through non-Probability sampling; purposive sampling. Field observations were also carried out through observation checklists to ascertain the information collected by the above instruments. The reliability of the questionnaire was determined using test-retest technique after being piloted in three locations of the Division. The data was recorded and analyzed using qualitative; narrative, and quantitative technique; descriptive statistical methods including frequencies, means and percentages then presented in form of tables, charts and graphs. The findings revealed that farmers' were knowledgeable about soil erosion phenomenon and aware of its occurrence as supported by (70.4%) of the respondents, the main causes of soil erosion were poor cultivation methods and practices, slope gradient and length, rainfall intensity and runoff and cultivation of marginal areas. The findings revealed that maize production was decreasing due to soil erosion as stated by 73.1% of the respondents and the mitigation methods currently applied by farmers to curb erosion were mainly channel terracing. The study concluded that farmers in Soy Division were knowledgeable about soil erosion as indicated by their ability to explain the meaning and identify its indicators. The farmers also perceived that soil erosion caused reduced maize yield due to factors such as the removal of top soil through soil erosion which cause loss of organic matter/residues and the disturbance or destruction of maize seeds and plants. The study recommended that farmers need to adopt conservation methods and practices that offer multipurpose benefits and soil and water conservation systems. The study further suggested that further studies could be done on the role of gender in the management of soil erosion and its role in maize yield, the role of government in soil and water conservation and the challenges faced in implementing land use policies.

DEDICATION

This study is dedicated to my family: Mrs. Beatrice Kandie, our daughter Sandra Jepkorir and sons Victor Rogony and Davis Sanai.

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LIST OF ABBREVIATIONS/ACRONYMS

CBOs	-	Community Based Organizations
D.A.O	-	District Agriculture Officer
D.C	-	District Commissioner
D.L.O	-	District Livestock Officer
D.O	-	District Officer
FAO	-	Food and Agriculture Organization
KARI	-	Kenya Agricultural Research Institute
LWS	-	Lower Water Shade
LSB	-	Level Stone Bunds
MDGs	-	Millennium Development Goals
MOA	-	Ministry of Agriculture
MoWD	-	Ministry of Water Development
NGOs	-	Non-governmental Organizations
NALEP	-	National Agricultural and Livestock Extension Programme
NSWCP	-	National Soil and Water Conservation Programme
S.B	-	Stone Bunds
SSA -		Sub-Saharan Africa
SWC-		Soil and Water Conservation
UN-		United Nations
UNDP-		United Nations Development Programme
UNEP -		United Nations Environmental Programme
UWS -		Upper Water Shade

CHAPTER ONE

Introduction

1.0 Overview

This chapter illuminates matters including background of the study, statement of the problem, objectives, significance of the study, assumptions of the study, scope and limitations of the study, area of study and definition of terms. It initiates the core concepts of the study that leads to the extensive structure of the entire research

Study.1.1 Background

Soil erosion is widely considered to be a serious threat to the long-term viability of agriculture in many parts of the world (Andraski, & Lowery (2002). The problem is particularly serious in developing countries, where the importation of food to substitute for declining domestic production due to soil erosion, and the growing scarcity of arable land may be severely affected by low foreign exchange earnings and high external debt burdens. Declines in agricultural productivity due to soil erosion would hinder economic development of a nation, particularly in the absence of other export opportunities and rapidly expanding populations (Savadogo 2000).

The mechanisms involved in developing solutions for soil degradation on agricultural land by research and extension agents need to be re-evaluated (Chambers et al., 1998). Traditional approaches to technological development and extension hardly considered farmers' knowledge. Despite experts' attempts to persuade farmers to control soil erosion, soil degradation continued unchecked, to understand clearly how farmers perceive soil degradation and the impact of technologies, a different approach needs to be tried out. Tendency to use the best land first, regardless of the scale of the land, have always controlled settlements and their expansion with moderate to high rainfall (Murwira, Swift and Frost. 1995).

In many developing countries, soil erosion and land degradation have become major environmental concerns and present a formidable threat to food security and sustainability of agricultural production. Access to land in Kenya and other African countries has become increasingly constrained in smallholder agricultural areas that were formerly land abundant. For land scarce countries, the long-term growth in food and crop production necessarily depends upon increased yields from land already under crops. The biggest challenge currently facing the Kenyan government is how to enhance food crop production so that food output can keep pace with population growth without increasing the land devoted to food crops, especially maize and milk (Webb, 2002).

The growing population in Kenya, combined with limited land availability in the agriculturally productive areas has led to increasing immigration to marginal areas in spite of their ecological limitations and vulnerability to severe land degradation through soil erosion. The feedback effects among these factors lead to a vicious circle of low productivity, poverty and land degradation (FAO, 2000). Although there is increased concern about land degradation in developing countries, there is paucity of non-empirical information on the impact of land degradation on farm productivity and poverty in fragile agricultural systems in Kenya (World Agroforestry Center, ICRAF, 2004). In this study we explore the impact of conventional inputs and adoption of soil conservation practices on farm productivity as well as the effects of institutional factors, notably the property rights in land (ownership), accessibility to and intervals of Agricultural extension service (Fritischel, 2002).

As soil erosion is a national problem the remedy lies in the application of soil and water conservation practices through a national soil conservation programme. However the farmers themselves have to carry out the necessary practices on their land as part of their farming system. For this purpose they need assistance through education, survey and machinery services, credit facilities and perhaps subsidies because even simple practices need skill, knowledge and equipment which they may not have, while the more complex practices need extra power and finance beyond their normal resources (Thomas et al, 1997). As soil conservation is an integral part of good farming and land use, such services should be supported and integrated with national agricultural, water and forestry institutions under one Ministry.

Government legislation can encourage or discourage good farming and conservation practice depending on priorities selected. The framing of legislation is not an easy task because of conflicting interests, and the balancing of short term economic goals with long term protection of the soil (Morgan 1995). The problem is of particular interest to developing countries whose economies are based mainly on agriculture and their priorities are easier to define because of the need to increase production and the standard of living of the peoples largely from the products of the soil. Soy Division in Keiyo South District, fall in the ASAL's region and soil erosion is not a new problem. It has been recognized since the 1960's (Hudson, 1995). However, this problem has taken a new meaning with the considerable immigration of people into this marginal dry area and a growing population. The region exemplifies most of the problems of marginal semi-arid areas.

Our study focuses on the impacts of soil erosion on maize yield based on peoples' views in the Elgeiyo-Marakwet escarpment and Kerio Valley, and on the causes and consequences of the factors contributing to the constant maize yield reduction and frequent food shortages, due to altered hydrological conditions, climatic change, land cover changes and mainly soil erosion. Erosion is a threat to the cultivatable land, both where it is used for agriculture or grazing, to the water quality and to the survival of the residents due to decreasing soil fertility. Soy Division is situated down at the dry semi-arid Kerio Valley floor and its catchment is stretching up on the surrounding slopes to the humid highlands. Therefore, the contributing causes to the erosion and reduction of maize yield as the staple food crop could be found all over the division. People’s perceptions of the problems are studied since many socio-economic and cultural factors have effects on the environment.

Given that rapid rates of soil loss are occurring on farms in many parts of the division, the study looked at the issue from socio-economic perspective at the farm level. This study examines the considerations taken into account by smallholder farmers in making decisions about soil depletion, crop productivity and soil and water conservation. The analysis focuses on the on-site and off-site productivity losses due to soil erosion in an attempt to understand farmers’ behavior in relation to maize production.

1.2 Statement of the Problem

Soil erosion is the principal threat to agricultural sustainability, affecting both the characteristics of the in-situ soil and its productive potential. Therefore soil erosion must be minimized in order to maintain productivity. In Soy Division, Elgeiyo-Marakwet County, substantial areas that are now under permanent, semi-permanent and pasture forms of agriculture were once forest or woodland. This ecological transformation strongly influences the rate of soil erosion. Since independence (past 50 years), Soy Division's population and corresponding food need has doubled. Today, thousands of people do not have adequate food. The Division's food supply situation is of concern **(**District Agriculture Office Chepkorio, 2014). Farmers do not produce enough food especially maize as the staple food crop to meet the Division's food security needs.

Despite the existence of a Soil Conservation Extension Unit, in the Ministry of Agriculture, the problem continues to increase as result of crop farming particularly maize cultivation as the staple food crop of residents. Consequently, the protection of soil against direct rain impact, the maintenance of organic matter and management of overland flow are critical for the prevention of soil erosion. Although there is general understanding of these processes and the range of remedial actions open to farmers, there is a continuing problem of erosion. Therefore this research mainly aimed to examine farmers' perceived impact of soil erosion on maize production as the staple food crop of residents in Soy Division, Elgeiyo-Marakwet County.

1.3 Objectives

The main aim of this study was to examine the impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County.

The study was guided by the following specific objectives:

i. To examine farmers' knowledge of soil erosion in Soy Division, Elgeyo-Marakwet County.

ii. To assess factors that influence soil erosion in Soy Division, Elgeiyo-Marakwet County.

iii. To explore farmers perceived impacts of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County.

iv. To assess soil erosion mitigation measures in Soy Division Elgeiyo-Marakwet County.

1.4 Significance of the study

This study was entrenched in the zeal to discover the intensity of perceptions of the effects of soil erosion on maize production among farmers in Soy Division. This study will lead to a deeper understanding of the concept and characteristics of soil erosion thus enable farmers to adopt appropriate soil conservation methods and cultivation practices that enhance soil fertility and improved maize yield. The study may contribute to the formulation of policies that guide in land use, soil fertility sustainability and strategies on soil and water conservation programmes and activities. The findings could be used to sensitize farmers on the importance of soil conservation and sustainable food production. It could also form a basis for further research.

1.5 Assumptions of the study

The study was guided by three main assumptions that:

i. Factors existed that could impede crop productivity and soil conservation.

ii. Generally soil erosion event tend to occur profusely in areas where farmers are unaware of its effects on maize yield and unaccustomed to soil and water conservation and sustainability measures.

iii. The targeted respondents would be accessible, willing and able to take part in the study.

1.6 Scope and Limitations of the study

1.6.1 Scope

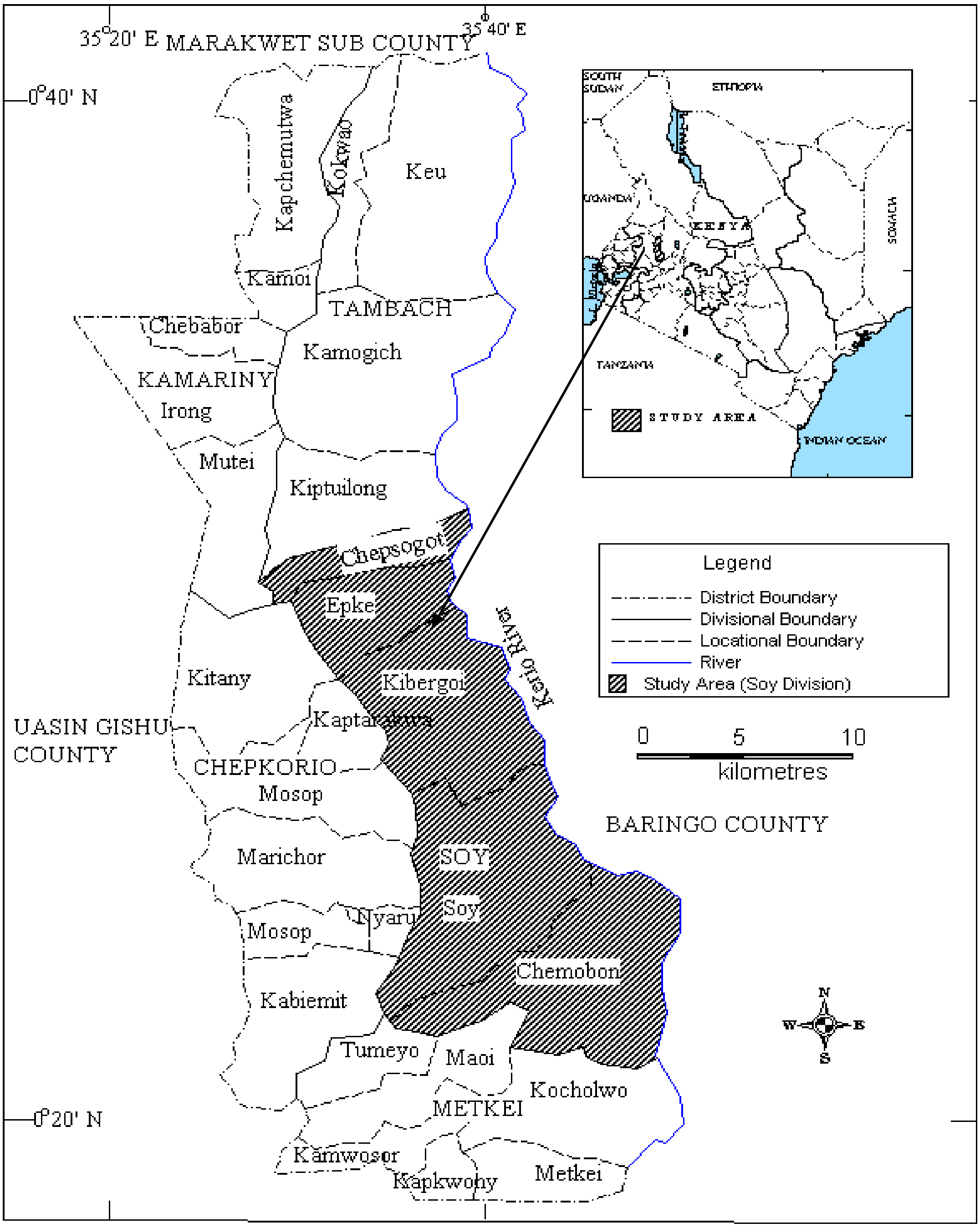
The study aimed to examine the impacts of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County. The study was restricted geographically to Soy Division. It was undertaken among residents who reside in Soy Division. The study targeted respondents consisting of farmers/household heads, Government officials from the Ministries of Agriculture, Water, Livestock, Environment, Non-Governmental Organizations and Community Based Organizations, and chiefs in Soy Division.

1.6.2 Limitations

The study encountered challenges including the busy schedule of the government officers and farmers as well as heterogeneity of the target population could not be ascertained easily. Some areas of the division particularly the escarpment have rough terrain hence accessibility to such areas was difficult due to either being impassable or non-existent roads. Other limitations were time and distance from one location to another across the division. However, despite the above shortcomings, various measures were taken including the use of motorbikes (Boda-boda), utilization of appropriate data collection procedures: viable instruments of data collection and booking appointments with government officials and the farmer respondents to save time and cost to ensure that the study process was objective, accurate, valid and reliable.

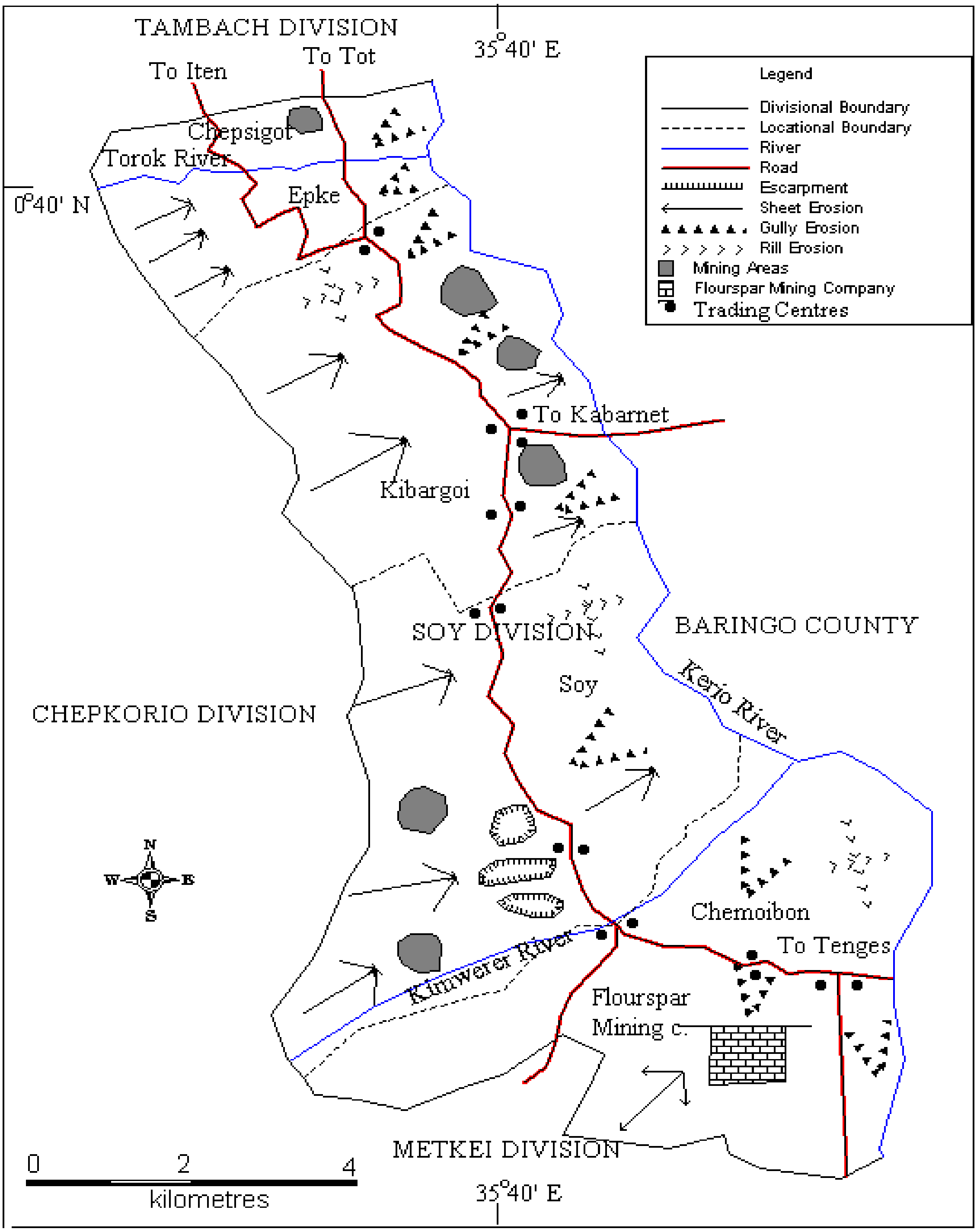
1.7 Area of Study

Soy Division of Elgeiyo-Marakwet County is in Kerio Valley region which lies between the Tugen hills to the East and the Elgeiyo-Marakwet escarpment to the West in a South- North direction. The valley floor is approximately 800-1000 meters above sea level. Soy is one of the Divisions of Keiyo-South District, found in the former Elgeiyo-Marakwet District; currently Elgeiyo-Marakwet County. It lies between latitude 00^0 01’ South and 00^0 12’ north and longitude 35^0 20’ west and 35^0 55’ east. It borders Baringo County to the east and south, Metkei Division to the south-west, Chepkorio to the west, Kamariny to the north-west and Tambach Divisions to the north. The Division covers a total area of 378.9 square km. It is divided into five locations and seventeen sub-locations, namely, Chepsigot (Kabito and Chebinyiny), Epke (Epke and Chepsigot), Kibargoi (Emsea, Rokocho, Cheptebo and Chang’ach), Soy (Chop, Morop, Muskut, Sego, Sogom and Turesia) and Chemoibon (Koimur, Chepsitei,and Tumeiyo). The Division falls in Keiyo South Constituency (District Development and Planning, Chepkorio, 2001).



(Source:District Agriculture Office, Chepkorio and Moi University GIS laboratory, 2012)

Figure 1.1 Administrative Boundaries of Soy Division



(Source: District Agriculture Office, Soy Division, Kimwarer and Moi University GIS laboratory, 2012)

Figure 1.2: Map of Soy Division: Study area

1.7.1 Settlement Patterns

Population in Keiyo District is unevenly distributed. Generally, the escarpment area has high concentration of population because it is well endowed with fertile soils and high amounts of rainfall (UNEP, 2000). The Escarpment and the Valley have low concentration of population. Soy Division lying partly in the escarpment and largely in the valley floor has the lowest total population of 22,138 and an average density of 58 persons per km^2 (District Statistics office, Chepkorio, 2001).

1.7.2 Physical Environment

The bio-physical features examined under this sub-topic comprises of topography, soils, climate and vegetation, all of which determine the eco-climate zones that characterize the study area.

1.7.2.1 Topography

Soy Division is divided into two main topographical zones, which run parallel to each other in a North-South direction. These are; the Elgeiyo Escarpment and Kerio Valley (UNEP, 2000). The Division lies between the large-scale farms of Uasin Gishu District on the west and the Kerio River on the east. The Kerio River, which is of regional importance, flows from its source in the southern part of the division draining into Lake Turkana and forms the eastern boundary. The Highland Plateau rises gradually from an altitude of 2,400 meters above sea level on Chebiemit Hills in the North to 2,700 metres above sea level on Metkei ridges in the South. Metkei ridges are an extension of the Mau ranges, the highest peak being Timboroa (2,890m) and the land falls in a series of steep scarps and flat plateaus that comprise of the

Elgeiyo escarpment and falling down into Kerio Valley floor which is between 800-1000 meters above sea level (Indeje., Semazzi & Ogallo, 2000).

The main water divide runs on north-south direction, along the edge of the escarpment. East of the divide is the Kerio catchment area which drains into Lake Turkana comprising of the area of study. West of the divide is the Lake Basin which drains into Lake Victoria. The main rivers are Kerio, Torok and Kimwarer (District development Plan-Keiyo South District, Chepkorio, 2001). The Kerio Valley is a low-lying stretch of land and volcanic activities have played a major role in shaping the land surface features in Soy Division and generally, Keiyo District's landscape. The floor of the Kerio Valley has a high concentration of mineral deposits (IPCC, The Intergovernmental Panel on Climate Change 2001). The Elgeiyo Escarpment is moderately potential in agricultural development due to its moderate rainfall and moisture availability while the valley floor has a marginal agricultural potential; though both areas have a high potential for livestock rearing, (Cooke Warren & Goudie, 1996).

1.7.2.2 Soils

The Kerio Valley has been formed by several phases of intensive volcanic activities. Most of the extensive rocks include basalts, phonolite, rocks and alluvial deposits. The rock formations in the region can be divided into three basement systems; metamorphic, tertiary, volcanic (extensive igneous) and quaternary alluvial deposits (sediments). Most of the coarse debris in these sediments is basement material derived from the escarpment (Aboudh A., Mutinda & Obweyere (2002). They are derived from pre-existing sedimentary rocks through mineralogical, chemical and structural processes, due to changes in temperature. Soils in the division vary with location and altitude, along Kerio River runs a zone of fluvisols while there are cambisols in the escarpment zone and luvisols on the slopes of the escarpment and the floor of Kerio Valley (Onyando, 2002).

1.7.2.3 Climate

Rainfall distribution in Soy Divison is highly influenced by altitude. In the escarpment where the altitude is high, temperatures are moderate and evaporation rate is low (Davies, Vincent & Beresford 1995). In the Eastern part of the district, which forms the Kerio Valley, being part of the study area and where altitude is low, low rainfall, high temperatures and high evaporation rates characterize the climate. In between these two extremes, there are variations as one drops from the highlands down the escarpment to the floor of Kerio Valley. The mean monthly temperatures vary between 17^{o} C and 22^{o} C. It is generally hot in the valley, moderately cold in the escarpment. The rainfall pattern is bi-modal in nature with long rains falling from March to June and short rains occurring between July and December (Camberlin, 1996)**.**

1.7.2.4 Vegetation

The vegetation that covers Soy Division is not homogenous as can be explained by the difference in altitude and the varying climatic condition. Parts of the Escarpment are covered with forests and cultivated land (UNEP, United Nation Environmental Program 2000). The East facing slopes are steep and covered with forests and plenty of undergrowth. Shrubs, herbs and trees cover some areas of the escarpment between the highland and the Escarpment. Vegetation cover in the escarpment is sparse. Acacia species, shrubs and herbs cover the Kerio Valley floor. Dry sub-humid climate is found in some parts of the Kerio Valley in Soy Division. In these areas vegetation consists of semi-evergreen bushland and comberetum or woodland savanna

(Sandström, 1995). On the escarpment climate is sub-humid and the vegetation is forest, derived grasslands and bushlands comprising of grasses, pennsetum varieties, Themeda and Eulusine Jaegeri (Sandström, 1995).

1.7.2.5 Economic Activities

The residents of Soy Division comprise of the larger Keiyo sub-tribe of the Kalenjin community) They practise agro-pastoralism in which they grow maize, beans finger millet, sorghum, cow peas, sweet potatoes and Irish potatoes; and rear animals such as cows, goats and sheep. Livestock plays an important part in their culture as it provides food, dowry and as a bank 'Bank of the hoof' or rather used to evaluate status of the family. Farming is also part of the economic activities in the lowlands, which are semi-arid (Jones, 1997). Drought resistant crops are mainly grown especially cassava and finger millet, maize and beans. Bee-keeping is a "peripheral" activity practised in the lowlands, and honey is used for medicinal purposes. Hunting is still carried out by young boys and herdsmen while herding livestock in the grazing fields as a way of complementing their diet and eliminating carnivorous animals such as leopards, lions and cheetahs that pose a threat to livestock and human life (Farm Management Guidelines, 2001).

1.8 Definition of terms

The following concepts are defined to convey the sense in which they were used in this study:-

Farmers' perception -refers to the understanding and views of people concerning certain issues. In this study it refers to the farmers' opinion on the effects of soil erosion on maize production.

Land degradation - refers to reduction or loss of the biological or economic productivity and complexity of rained cropland, resulting from land use or a process or combination of processes arising from human activities and habitation patterns such as: soil erosion caused by water; deterioration of the physical, chemical and biological or economic properties of soil.

Maize production - refers to the process of growing or making food, goods or materials. In this case the quantity of maize that is produced for use or sale.

Soil degradation - refers to a decline in soil quality encompassing the deterioration in physical, chemical and biological attributes of the soil. It is a long term process enhanced by accelerated soil erosion.

Soil Erodibility - refers to an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil type. Generally, soils with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion.

Soil Erosion - refers to a loss in soil productivity due to: "physical loss of topsoil, reduction in rooting depth, removal of plant nutrients, and loss of water or gradual washing away of top soil through agents of denudation mainly water and man through land use/management.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter focused on reviews of various literatures on cases of farmers' perceptions of soil erosion, characteristics, causes, conservation and consequences especially with regards to maize production. The information was obtained from books, journals, newspapers, internet and previous works by other researchers, summary was made, criticism from various authors, and finally conceptual framework and the theory of study were highlighted.

2.2.1 Global Point of View

Erosion adversely affects crop productivity by reducing water availability, the water holding capacity of the soil, nutrient levels, soil organic matter, and soil depth (Pimentel and others 1995a). Estimates are that agricultural land degradation alone is expected to depress world food production between 15% and 30% during the next 25 year period (Andraski, & Lowery, 2002), emphasized the need to implement known soil conservation techniques, including, biomass mulches, and no till, ridge till, grass strips, shelterbelts, terracing, contour planting, crop rotations, and combinations of these. All of these techniques basically require keeping the land protected from wind and rainfall effects by some form of vegetative cover (Sanchez, Shepherd; Soule, Place; Buresh, and Izac. 1997). In the United States during the past decade, soil erosion rates on croplands have decreased nearly 25% using various soil conservation technologies. Even with this decline, soil is still being lost on croplands at a rate 13-times greater than the sustainability rate (Pimentel and others 1995b). Although soil erosion has declined on croplands, soil erosion rates on pastures and rangelands have not declined during this same period.

Such reports asserted that the transfer of proper tools and techniques to ill-equipped and erosion-inducing peasants would stem erosion. Market signals and articulation of the peasant economy with agricultural businesses, it was thought, would induce the necessary innovations and transfer modern technologies (Hellin, and Schrader, 2003). But capacity of the peasant sector in Cochabamba to generate market demand for modern technologies declined steadily during the 1980s, and agribusiness integration remained restricted to small areas within the overall peasant economy (Palm et al., 1997**)**.

In Honduras, many farmers talk about ‘rocks growing out of the hillside’. As farmers cannot see this erosion occurring, the explanation of rocks growing is a logical explanation for rocks becoming exposed (Hudson, 2002; 1995).The major worry of farmers in Honduras is the damage caused by pests and diseases, drought and irregular rains. Soil erosion is seldom seen as a threat to their livelihoods. Deeper questioning reveals that farmers are not worried about pests and diseases or reduced rainfall as such. Their real concern is what these problems will mean to them in terms of reduced productivity (Hellin, and Haigh, 2002). Soil erosion control has received so much attention due to the assumption that there is a direct relationship between soil loss and crop productivity. Conventional soil conservation technologies, focusing on controlling soil loss, tackle what outsiders consider the main threat to (and from) farming on sloping lands rather than the problems and priorities identified by the farmers themselves (Hellin, and Schrader, 2003).

Family farms produce about 80 percent of the world's food. Their prevalence and output mean they "are vital to the solution of the hunger problem" afflicting more than 800 million people, FAO Director-General José Graziano da Silva wrote in the introduction to FAO's new State of Food and Agriculture 2014 report. Family farms are also the custodians of about 75 percent of all agricultural resources in the world, and are therefore key to improve ecological and resource sustainability. They are also among the most vulnerable to the effects of resource depletion and climate change. While evidence shows impressive yields on land managed by family farmers, many smaller farms are unable to produce enough to provide decent livelihoods for the families. Family farming is thus faced with a triple challenge: yield growth to meet the world's need for food security and better nutrition; environmental sustainability to protect the planet and to secure their own productive capacity; and productivity growth and livelihood diversification to lift themselves out of poverty and hunger. According to the SOFA report, all these challenges mean that family farmers must innovate.

2.2.2 Regional Point of View

Tamene et al. (2006) indicated that some 50% of the highlands of Ethiopia were already significantly eroded, and that erosion was causing an annual decline in land productivity of 2.2%. For several decades, an attempt has been made to address the soil erosion problem in Ethiopia by means of different approaches and programmes to ensure the sustainability of agricultural production. The largest soil and water conservation (SWC) activities in the country were implemented during the 1970s and 1980s, mainly in a food-for-work programme (Woldeamlak, 2006).

In a similar study in Northern Ethiopia (Alemayehu, 2007), the majority of the interviewed farmers responded that terraces increased soil fertility, improved moisture status and increased crop yield. Furthermore, in the Gunono area of Wolaita in southern Ethiopia, 80% of the farmers were of the opinion that soil bunds increase yields (Esser et al., 2002). The study conducted by Nyssen et al., (2006) in Northern Ethiopia showed that 75.4% of the farmers were in favour of stone-bund building on their land, which is a clear indication that the local community perceives this conservation measure as beneficial. Another survey in Hagere Selam, Tigray by Esser et al., (2002) also showed that 80% of farmers responded that investments in SWC were profitable, and 68% were of the opinion that conservation practices led to increased yields in normal years.

Since farmers in a subsistence economy accept and use conservation technologies that enhance productivity and provide short-term benefits (Aklilu and Graaff, 2006b), the perceived increase in yield within a few years, may encourage them to continue to adopt it (Araya and Asafu-Adjaye, 1999). In the LWS, SB created a fertility gradient in the inter-structure area, that is, fine soil accumulated in the upslope part of bunds. This was due to tillage erosion related to the surface gradient, and was aggravated by the number of boundaries created (Nyssen et al., 2000; Desta et al., 2005; Li et al., 2006). On the other hand, soil erosion from the upper slopes in the interstructure area removes fertile soil, whereas excessive accumulation occurs on the lower slope (Nyssen et al., 2006). McConchie and Huan-cheng (2002) also reported that rock terraces trap a greater thickness of soil on the slope, increasing the risk of slope failures, reducing moisture and nutrient availability to plants, and thinning the soil upslope.

2.2.3 Local Point of View

Historical evidence shows that Kenya started experiencing high soil erosion rates as early as in the 1930s leading to the establishment of the Soil Conservation Service (Thomas *et al.*, 1997). The problem of soil erosion was exasperated when the colonial government introduced a land use policy after many European settlers came and took up farming in Kenya. This policy resulted in the resettlement of large numbers of African farmers and pastoralists, assigning them restricted zones or native reserves, of limited agricultural potential (Nandwa *et al.*, 2000). The growth of human and livestock population in the native reserve areas led to land degradation. The colonial government used the issues of land degradation to justify government control over African lands. The European settlers also used the same issue to promote expansion of their landholdings. The colonial government then introduced some regulations to help in controlling the problem of soil degradation. Farmers were not allowed to plough steep land, cultivate along stream channels or clear forests.

Currently soil and water conservation activities in the country are being managed through the National Agricultural and Livestock Extension Programme (NALEP) under the ministry of Agriculture (MOA). NALEP aims at harmonizing approaches in public extension services by targeting at a broader and more farmer-oriented extension service, which is better equipped to meet the needs and demands of the small-scale farming population. It builds on existing resources and experience gained by earlier programmes and projects in the ministry of Agriculture (MOA) such as National Soil and Water Conservation Programme (NSWCP).

However there is lack of support from the government in the promotion and implementation as the soil and water conservation branch of the ministry of Agriculture, which coordinates soil conservation work throughout the country, has had very little interest in vetiver grass system and the general use of vegetative measures and instead more emphasis has been placed on the structural measures. As a result most of the agricultural extension staff and farmers have little or no knowledge at all of the Vetiver System. They also lack technical information on the establishment and management of the vetiver grass (Thomas et al, 1997, Nandwa et al, 2000). The adoption of the Vetiver grass system technology in Kenya has been quite slow; due to slow growth rate compared to Napier grass and low palatability to livestock (Owino, 2002).

Maize is the staple food in Kenya (Mantel, 1999). Large as well as small-scale farmers produce the crop and a large percentage of the population depends on Maize farming as an income-generating crop. Maize is a tall annual crop of the grass family. Maize was first cultivated in America by the Indians. It was taken to Europe by Christopher Columbus. It has since spread to many parts of Africa and Asia. In Kenya it was first introduced by the Portugese at the coast in the 15th Century (Mantel, 1999). Since maize is adaptable to a whole range of climatic conditions and alongside other subsistence crops like beans, potatoes and bananas. Good yields are obtained with use of hybrid seeds supplied by Kenya Seed Company. The Kenya Agricultural Research Station has developed a special kind of hybrid maize called Katumani, which is adapted to the drier conditions.

2.3.1 Farmers' Knowledge of Soil Erosion

According to survey carried out by Mokma, Sietz, Soil (2002), farmers' in Bolivia the causal sequence in erosion originates in the break-down of customary social rights and obligations. The success of soil conservation projects depends on favorable policies for peasant farm production."Little voices" articulated by Cochabamba peasants demonstrated that local knowledge of soil erosion is extensive and that it complements peasant expertise about such biophysical features as climate, crops, and plants and animals in general. However the study did not focus on farmer perceptions on the impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which this study aimed to fill.

In Runyenjes Division of Embu District, majority of farmers keep some livestock using zero grazing methods (Wanjogu, 2001). The main food crops are potatoes (Solanum tuberosum), maize (Zea mays) and beans (Phaseolus vulgaris). The first survey focused community survey involving transect walks and village group meetings in all of the seven villages by a team of researchers and extension officers were guided by the key informants drawn from all the villages in the research area. The administrative chiefs of the two locations identified the village leaders and these appointed 2–3 other full-time committed farmers in their respective villages (Snowballing sampling technique). Together these formed a team of 28 key informants who facilitated the study. During the second survey, 120 farm households were interviewed using semi-structured questionnaires. Their competence also was pre-tested in these issues before pre-testing the questionnaires on a sample of farmers.

Key informants; Observed that the alternative option for hybrid seed was the use of ‘recycled’ seed or sometimes borrowing planting seed from neighbours (usually not hybrid). Apparently the other farmers depended on ‘recycled’ seed. Soil fertility amendment methods; A relatively high proportion of poor land managers used farmyard manure (FYM) as the sole source of improving soil fertility. A high percentage of good and moderate land managers tended to use a combination of organic (e.g. FYM) and inorganic fertilizers instead of purely relying on either inorganic or FYM fertilizers, as was more common with poor managers. Combining the fertility sources demonstrated the great desire to achieve higher yields when the complementary effects between organic and inorganic nutrient sources are employed. Kapkiyai et al. (1999) established that use of organic matter (FYM or maize stovers) alone as fertility source gave much lower maize yields than when both the organic and inorganic sources were combined (Bewket, 2003). However the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which study aim to fill the gap left by Wanjogu, 2001.

2.3.2 Factors that influence soil erosion

The rate and magnitude of soil erosion by water is controlled by the following factors: Rainfall Intensity and Runoff; the impact of raindrops on the soil surface can break down soil aggregates and disperse the aggregate material (Abera, 2003). Soil movement by rainfall (raindrop splash) is usually greatest and most noticeable during short duration, high-intensity thunderstorms. Runoff occurs whenever there is excess water on a slope that cannot be absorbed into the soil or trapped on the surface. The amount of run-off is increased if infiltration is reduced due to soil compaction, crusting or freezing. Runoff from the agricultural land may be greatest during rainy seasons when the soils are saturated, and vegetative cover is minimal (Omaffra staff; Wall 2005). However the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County ,which Abera, (2003) and Omaffra staff; Wall (2005), left to be filled.

The farmers’ perceptions are in agreement with Sierra Leone farmers who associated the erosion problem on their land with high rainfall, steep slopes and lack of vegetation (Bayard, Jolly, 2007). Field observations showed that erosion indicators were more evident on steep and gentle slopes than on very steep slopes. Few farmers observed splash pedestals and stoniness and associated their development with high rainfall, runoff and steep slopes. Results also showed that farmers attributed the appearance of red soil, stoniness and splash pedestals to factors other than the impacts of rainfall and runoff only. However Bayard, Jolly, (2007) did their study in Sierra Leone the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya.

Slope Gradient and Length, naturally the steeper the slope of a field, the greater the amount of soil loss from erosion by water. Soil erosion by water also increases as the slope length increases due to the greater accumulation of runoff. Consolidation of small fields into larger ones often results in longer slope lengths with increased erosion potential, due to increased velocity of water which permits a greater degree of scouring (carrying capacity for sediment), (Trimble 1994; Trimble and Mendel 1995). Vegetation and residue combinations that completely cover the soil, and which intercept all falling raindrops at and close to the surface and the most efficient in controlling soil (e.g. forests, permanent grasses). Partially incorporated residues and residual roots are also important as these provide channels that allow surface water to move into the soil (Lekasi et al., 2001). Form the study done by Trimble (1994), Trimble and Mendel (1995) and Lekasi et al., (2001) only concentrated on Slope Gradient and Length that increases soil erosion, yet out study was on various factors that influences soil erosion.

Loss of vegetative cover is especially widespread in developing countries because population densities are high, agricultural practices frequently are inadequate, and cooking and heating often depend on the use of crop residues for fuel. For example, about 60% of crop residues in China and 90% in Bangladesh are stripped from the land and burned for fuel (Wenner, 1993). In areas where fuel wood and other biomass are scarce, even the roots of grasses and shrubs are collected and burned (Teshome, Rolker , de Graaff , 2012). Such practices leave the soil barren and fully exposed to rain and wind energy. Erosion rates on sloping lands are exceedingly high. Erosion rates are high especially on marginal and steep lands that are being converted from forests to agricultural use to replace the already eroded, unproductive cropland (Barz, et al., 2007).

Although world agricultural production accounts for about three-quarters of the soil erosion world-wide, erosion also occurs in other human-modified ecosystems (Biruk , 2006).Natural areas also suffer erosion; this is especially evident along stream banks. On steep slopes (30% or more), a stream cut through adjacent land can cause significant loss of soil (Bayard, Jolly, 2007). The presence of cattle in and around streams further increases stream-bank erosion. For example, in Wisconsin, a stream area inhabited by cattle lost about 60 tons of soil along each kilometer of stream length per year. As expected, erosion accompanies landslides and earthquakes (Desta G, et al., (2005). From the above study done by Biruk (2006), addressed that natural areas had suffer erosion this is especially evident along stream banks, however the current study looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County.

2.3.3 The Effects of Soil Erosion on Maize Production

Yields are actually determined by a complex interaction of factors including soil quality, crop and land management systems, and climate. In countries such as Honduras, the amount and distribution of rainfall has a much more profound impact on yield than the amount of soil eroded. Given such variation in yields, farmers' 'failure' to identify soil erosion as a threat to their livelihoods seems reasonable (Hellin and Haigh 2002). A soil in good condition is well structured, allows roots to penetrate exchanges gases and absorb rain easily. The more rainfall is absorbed, the less erosion takes place. Erosion occurs once the soil is degraded. A degraded soil is less able to absorb rainfall and the result is greater run-off and erosion. Cross-slope technologies, such as live barriers, do little to improve the quality of the soil between the barriers. As a result, farmers seldom witness an improvement in production as a result of such soil conservation efforts. Clearly, there is a need for a new approach to soil conservation. The farmers' concerns agricultural productivity and its sustainability through the preservation and improvement of soil quality provides the starting point for this approach and should be given priority (Dale, Polansky, 2007).

Therefore, lack of nitrogen leads to stunted growth of crops followed by pre-mature yields while low potassium leads to poor development of leaves, stem and branches of the plant hence low yields. Similarly, CEC deficiency affects the total amount of nutrients available to plants as exchangeable cation and therefore leading to poor yields. These low levels of macro nutrients are as a result of soil erosion and land degradation caused by continuous farming and grazing of crop land and non crop land. This calls for use of fertilizers which is beyond the reach of majority of households. With increased population comes the need for more food. In the last 10 years, large amounts of food had to be most productive agricultural areas that normally produce enough food to be considered close to being self-sufficient often had serious crop failures. Maize is the main staple crop of Kenya and accounts for approximately 80 percent of total cereals (rice, wheat, millet, and sorghum) grown. Other primary crops include beans, coffee, tea, and bananas.

Under the Vision 2030, the Government has identified the following seven flagship projects for implementation during the next 5 years:- .Agricultural policy reforms, three-tiered fertilizer cost reduction, branding Kenya farm produce, establishment of livestock disease free zones and processing facilities, creation of publicly accessible land registries ,development of agricultural land use master plan and development of irrigation schemes. According to FAO (2014) crop production data in Kenya for 1999 and 2000, the total domestic production available for consumption in 2000/2001 was about 1.85 million tonnes. However, maize stocks were depleted at all levels throughout the country. The maize harvest was estimated to be 20 percent below average. Total maize production in 1999 was 8 percent below 1998s and 17 percent behind the previous 5 years. In 2000, FAO estimated that Kenya would need to import about 1.4 million tones of maize to meet basic food requirements. Between 1994 and 2000 maize imports rose from approximately 150,000 tonnes to almost 1,400,000 tones. This devastating trend appears to be ongoing (Forster, 1994).

In the past, traditional Kenyan farming methods included shifting cultivation where farmers, after a regular interval, moved or shifted crops from one area to another.

Increasing trend of using available land and not allowing it to recover is illustrated by Ovuka (2000), who reports that between 1960 and 1990, in Kenya's highly productive Central Province, the land area allocated to fallow decreased from 15 percent to 6 percent in Maruagua, and from 14 percent to 2 percent in Mbari-ya-Hiti. This trend is also evident in the highlands of western Kenya. In the northern portion of the Trans-Nzoia District (considered part of the "Bread Basket" of Kenya):- fallow periods on many subsistence farms have been significantly reduced in the last 30 years. Local farmers reported that, in many cases, fallows were as long as 9 years. However, due to increased land pressure, smaller land holdings and increased need for food, the fallow periods have been reduced in many cases to less than 1 year (de Graffenried, 2003). In fact, many subsistence farmers continuously crop and use no fallow.

Crop yield and soil nutrient status can be used as indicators of soil productivity. Soil productivity is defined as the productive potential of the soil system that allows the accumulation of energy in the form of vegetation (Mwakubo, 2004). Declining agricultural yields appear to support the idea that severe soil loss has a negative effect on Kenyan agriculture production ICRAF (2004). Erosion has great potential to negatively affect agricultural production. Maize is one of Kenya's primary food and cash crops and its growth is therefore maximized (Stocking, 1998; 2002). In general, the results of Mantel's research support the idea that the impact of soil erosion on land productivity depends on soil type and terrain characteristics which Mwakubo, (2004) and Abera Belachew (2011) which the study fill to address.

The farmers' description is in agreement with scientific knowledge that slope steepness affects land productivity (Lal, 1994; Morgan, 1996; Rockstro¨m et al., 1999). These reports show low yields of maize and millet on fields located on steeper slopes that are often severely eroded. The yield reduction was attributed to decreased availability of water-holding capacity on severely eroded fields. The farmers' knowledge is also in agreement with findings by Steiner (1998) on farmers in Rwanda who associated soil suitability with slope position. Steeper slopes generally had shallower soils whereas on plateaus and foot slopes fine-textured soils dominated, implying soils of high fertility. However the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which study aim to fill.

Despite the high-density tree-crop integration system (agroforestry) the contribution of trees to SWC was not recognized by farmers. Tree planting has always been promoted as a source of construction timber and fuel wood but not for soil erosion control, given that trees' dominant niches are on farm boundaries. Farmers viewed trees as a great source of farm cash income, given the restriction to logging in government forests. Biruk (2006) found that farmers were not willing to adopt trees within cultivated fields as SWC measures, only on boundary niches, primarily because they were good live fences, which ensured land tenure security and caused nutrient competition and soil erosion, due to the splash effect generated under tree canopies. However the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which study aim to fill.

The majority of farmers perceived that SWC measures increased crop yields, improved soil fertility and improved soil-water retention capacity of the soils (United Nations Food and Agriculture Organization (FAO), (2002). Due to the high land-tenure security enjoyed by almost all Kenyans, and particularly in the high-potential regions of the country, the tendency to mortgage land or sell a portion of land is very common. Banks and other financial lending agencies estimate the value of land on basis of many on farm attributes, which include farm house(s), trees, and the agricultural potential of the land under consideration. Farmers recognized that SWC measures on a farm could or did enhance land market value. Few farmers believed that SWC measures could assure long-term productivity of the land which implied that farmers were likely to invest in simple and cheap short-term benefit measures rather than going for the recommended mechanical structures such as bench terraces and fanya-juu (United Nations Food and Agriculture Organization (FAO, 2014). However the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which study aim to fill.

Because of the top-down enforcement to adopt mechanical SWC measures that were not properly implemented, farmers had formed an opinion that conservation measures were less successful in soil-erosion control Farmers listed several constraints encountered when adopting SWC measures. Generally, the main constraints were lack of money and an insufficient labour force to undertake conservation measures. The next important constraints were lack of tillage tools and poor knowledge about the benefits of SWC measures. Land tenure, construction know-how, size of farm and women-headed households were least recognized constraints to the adoption of SWC measures, against popular beliefs (Tenge, et al., 2004). The women headed households were not regarded as a hindrance to adoption of SWC measures given the emphasis by donors of SWC programmes on gender considerations when designing and planning for SWC measures (Pretty et al., 1995). However the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which study aim to fill.

Also, level of education has demystified traditions biased against women in Africa, and has improved womens' participation in SWC programmes (Pretty et al., 1995). Therefore the cause of the current low motivation to increase and maintain the number of SWC measures might be due to adoption constraints, listed in this study. With regard to land-tenure security, most farmers in the study area have title deeds. Studies in the Philippines and in the Ethiopian Highlands have shown that security of ownership was not always a necessary condition for the adoption of SWC measures factors like kinship, rental contracts and share-cropping arrangements improved investment decisions (Lapar and Pandey, 1999; Kidanu, 2004). This study found that farmers with land-tenure security other than title deeds, tended to adopt low labour-intensive SWC options. Some of the listed adoption constraints were the lack of labour and tillage tools. Possibly because the more SWC measures a farmer had, the more effectively erosion was controlled. And this led to higher productivity and higher cash income and helped to solve the other constraints typically experienced by small-holder farmers (Tenge et al., 2004). However the currently study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which study aim to fill.

It was established that farmers were aware that soil erosion was damaging their land. Ninety-eight percent of farmers experienced soil erosion, a phenomenon they related to the widespread on-site erosion indicators. Rills were most often mentioned; followed by root exposures, sheet wash (runoff flow paths) and the change of soil colour to red (red soils). They attributed the formation of these indicators to factors that included: high rainfall, runoff from upslope fields, steep slopes and poorly designed or ineffective SWC measures, which they find themselves incapable of changing. Farmers attributed soil fertility levels and crop-yield potential to slope position, knowledge the household employed when identifying suitable fields for certain crops and sharing out land among household members. Fields on flat and gentle slopes and in the valley bottom areas were perceived to have highest potential for crop production. Fields on steep and very steep slopes were perceived to be eroded and hence were unlikely to realize high crop yields. Farmers perceived that increased crop yield could be realized, through improved husbandry practices, such as the implementation of SWC measures.

In addition to increased crop yield, SWC measures were perceived to improve soil fertility, soil-water retention and even increase the market value of that land. Apparently farmers were knowledgeable about various SWC measures but only implemented a few of them. Low appreciation of the widespread agroforestry systems in the research area as a soil conservation measure implied that farmers were more interested in tree by-products (woodfuel and construction timber), than the scientifically perceived effects of trees on SWC. Even though farmers had knowledge of many types of SWC measure, widespread adoption was still constrained. The most important constraints were lack of capital and tools, labour shortage and construction know-how (Bationo, et al, 2007). However the current study only looked at farmer perception on impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya, which study aim to fill the gap left by Bationo, et al, 2007).

2.3.4 Soil Erosion Mitigation Measures

FAO, (2000), in examining community initiatives in conservation programs, suggested that "On a terrace with a 30% slope the construction of a 3.5 meter wide bench terrace, construction of sheltered evacuation canals, soil improvement and fertilizer". Such labour commitment is beyond most farm households where even the maintenance of terraces and purchase of technology to undertake terracing is difficult (Hanna, Folke , and Mäler 1995). Carl Wenner developed, in association with the Kenyan Ministry of Agriculture, a series of extension exercises to reduce erosion. At farm level, he stated that four factors influenced soil erosion: the quantity and energy of rainfall; the physical erodibility of the soil; the length and steepness of slope; and the crop management system. He focused attention on improved crop management combined with simple terracing practice (Siegrist, Gutscher, 2006).

During the growing season, he emphasized the importance of ground crop cover to reduce rainfall impact. During off-season, emphasized on maintaining a continuous layer of crop residues to reduce surface run-off and increase the rate of infiltration and water retention in the ground (Versteeg et al., 1998). Special attention also was given to contour ploughing and crop rotations to maintain soil structure. Given the constraints on terrace building, he promoted a program in which government action would focus on providing cutoff drains to remove excess water from areas outside the farm, especially to retard gully development, while farmers had responsibility ("self-help") for "with-in-farm" conservation. Wenner designed simple terracing procedures, concentrated on building bench terraces because they changed the degree of slope, retarded runoff and retained eroded soil, moisture and nutrients. Bench terraces were built from grass strips which acted as wash stops. The grass strips were unploughed strips, planted grass or trash lines laid along the contour (Illukpitiya, Gopalakrishnan, 2004).

Central to conservation of soil, fertility, water, energy and labor, will be the development of zero tillage. Lal (1994) who pioneered no-till agriculture has shown that in Nigeria losses on tilled land could be as high as one ton per hectare per month on ten percent slopes, even under crops. Untilled production reduced erosion by 98 percent and significantly reduced water runoff. Zero tillage also requires less than 10 percent of energy and labor input. Generally, reddish-brown earths are suitable for zero tillage (Thaxton 2007). Using zero tillage, subsistence farming could increase soil productivity. Zero tillage, however, requires the development of two technologies; appropriate herbicides and applicators for pre-and post-planting applications as well as punch or injector planters to penetrate the soil (UN 2005).

The multipurpose role and benefits from grass strips could explain the high adoption rate. Grass strips serve as a main source of fodder for livestock as well as a good filtering hedge against runoff water. They are also used to stabilize risers of fanya juu terraces. Farmers tend to go for short-term return systems (mulching and grass strips) rather than labour-intensive conservation systems. Awareness and adoption of bench terraces and fanya juu measures can be linked to the colonial legacy whereby these measures were adopted by coercion (Kiara et al., 1999).

According to Hellin, and Schrader (2003), a more effective approach than focusing on cross-slope soil conservation technologies is the use of agronomic, biological and mechanical measures to improve soil quality via soil protection, the incorporation of organic matter and the use of soil organisms. These procedures directly address factors such as surface cover and soil structure, that are within the control of the land user and that can be used to rebuild the soil into a dynamic and living system. Soils that favour root growth also favour better water retention and the conservation of soil and water on the farm itself. Improving soil structure and infiltration capacity can result in improvements in both production and soil conservation (Kiara, et al., 1999).

Improvements in crop management, such as early planting, optimum density, leaving crop residues on the surface and the use of green manures, reduce erosion, encourage water infiltration and, through improving soil quality, lead to improved crop production (Bewket, , 2007). A practical example of this approach is the Quesungual system in Western Honduras; an agro-forestry system that is characterized by three layers of vegetation: mulch, crops and dispersed shrubs and trees. Farmers in Western Honduras used to practise a slash-and-burn agriculture. Different development organizations encouraged them to stop burning their fields prior to planting their maize crop and instead to cut the weeds, leave them on the soil surface and sow their maize seed through the mat of vegetation. The three-tiered vegetation canopy affords ample protection to the surface of the soil and as soon as the farmers stopped burning they noticed there was hardly any erosion: the rivers were ‘clean’ as opposed to ‘dirty’ when it rained. Soil erosion control is not, however, the reason that farmers are increasingly adopting this system. The issue at stake is improved soil quality (Rockstro¨m J, et al, 1999).

Having abandoned the practice of burning their fields, there are more beneficial insects and increasing levels of organic matter in the soil. The attraction for farmers is that the soil can now hold moisture much better. The result is improved production. The reduction in soil loss is a ‘secondary’ benefit of the system. Farmers do not see the Quesungual System as a soil conservation practice. On the contrary, it is viewed as a productivity-enhancing practice that also happens to be effective for soil conservation. This approach to land management is more attuned to the farmers' priority needs and is more readily adopted by them. The Honduras experience shows that, although there is still a role for cross-slope conservation technologies, these should be combined with technologies and agronomic practices that lead to an improvement of soil quality. If used on their own, they are unlikely to result in improved productivity, which is the farmers' main concern (Morgan RPC. 1996).

Recent positive experiences with the rapidly expanding zero tillage systems of Latin America show that when soil quality is improved, agricultural production increases and soil erosion is reduced. Fundamental policy changes are, still needed to alleviate the pressure on the steep lands of Central America (Bayard, 2007). These changes include more equitable land distribution and greater access to markets. However, despite numerous social, economic and agro-ecological constraints to better land management, farmers can improve soil quality through the use of technologies that enhance both productivity and soil conservation. Through such approaches Central America's hillsides can support more smallholder farmers on a more sustainable basis (Hudson 1995).

A study done by Woldeamlak (2006) showed that 94% of the interviewed farmers in northern Ethiopia believe the physical SWC measures have the potential to improve cropland productivity, and lead to increased crop yield. Since the gradient of most farmland in the watershed is steep, there is an increasing tendency towards erosion. The channel of the LSB traps and retains surface runoff from the upslope area, which would otherwise erode everything within the cropland. In the LWS, the soil is shallow, and experiences low rainfall and recurrent drought. Thus, the role of structures in reducing runoff, reducing soil loss by water erosion and retaining water, was noted by farmers as improving agricultural production in both the lower and upper watershed areas (Hans 2006).

The household survey and group discussions revealed that, watershed management activities, particularly LSB and SB, have a positive effect on combating soil erosion, and a potential for sustainable land management towards the improvement of crop productivity, if they are properly managed (Ludi, 2004). They recognized that the structures had improved the soil and crop production by reducing soil loss and conserving water (Herweg and Ludi, 1999).

The performance of crops or natural grass, the presence or absences of signs of runoff and erosion in the inter-structure area, and the accumulation of sediment near structures, were frequently used as evaluation criteria. These criteria in turn indicated a reduction of soil loss from cropland and improved soil moisture retention. The use of crop residues for livestock feeding and mulching was a common practice across all land-management classes. Livestock, particularly goats, sheep and cattle in the research area, are zero grazed and occasionally tethered within the farm. It was not a common practice for farmers to sell maize stovers (Beck, 2005).

The types of Soil Erosion including splash erosion is the scattering of loose soil particles by falling raindrops; the first effect of rainfall on bare soil. Sheet erosion is very common on lands with little or no vegetation. It erodes the top layer of the soil and exposes infertile sub-soil, thus leading to severe loss of plant nutrients. It is easily recognized if subsoil or plant roots are exposed. Sheet erosion can have serious effects on the soil Rill or finger erosion occurs when furrows make a path for water flow such as small streams. Sometimes, the flowing water on the exposed land creates finger-like channels on the land (Gachene and Kimaru , 2003). This kind of erosion leads to gully erosion, which is referred to as the most destructive kind of erosion (Gachene, 1997). Gully erosion is destructive to farmland and is the most common type of erosion in Soy Division and the general Keiyo Marakwet County. When it is too deep, it can render the farmland uncultivable and unproductive.

In southern Malawi, farmers do not have livestock, (Thangata, 1996). The government of Malawi uses a centralized, top-down, "block-extension-system" approach to extension needs. This is a modification of the train and visit approach introduced in the 1980s. This approach has proved to be unresponsive to farmers' needs and priorities. Farmers used to attend extension meetings when the government was offering fertilizer credit. Now they do not see any reason to attend the meetings and there is low extensionist to farmer contact. Every extension planning area has one land husbandry officer who is responsible for the soil and water conservation and agroforestry activities (Ministry of Agriculture, 1993/1994).

In western Kenya (KARI Kisii – 1994; 1995; Odendo and Wasike, 1999), results from a combination of conservation structures (Fanya juu terrace; grass strips; trash lines) and types of forage grasses (Napier; panicum; makarikari; Rhodes) in Cheptuya, West Pokot, showed that farmers preferred conservation structures in the order of grass strips, trash lines, bench terraces (Khaemba *et al.*, 1999). The grasses were preferred in the order of Napier, Rhodes, panicum, makarikari, showing that farmers preferred less labour intensive biological conservation structures with grasses/fodders that can be utilised as livestock feed (Nzabi *et al.*, 2000).

Among the ideal soil erosion policies in Kenya encouraged were contour farming; tree planting on hillsides, terracing, strip cropping and destocking of herds in certain areas. Conservation measures such as grass strips, trash-lines and rotational grazing were promoted to supplement terraces. Compulsory communal work was organised for terracing, grass planting, and large areas were closed off to prevent grazing (Tiffen *et al*., 1994). These measures were implemented by coercion under local chiefs, headmen, and technical assistants (Thomas *etal*., 1997). Because of this, farmers were reluctant to maintain the structures, and as a consequence the policy failed in the long term (Kinyanjui *et al*., 2000).

Kenya's population with a yearly growth rate of 2.8 is projected to reach 51 million by 2025 Vision 2030 should plan for and ensure an equivalent economic growth to accommodate its growing population areas (UNPD 2008). Increasing the number of people living in the same area adds pressure on land and its resources. The Government of Kenya understands and appreciates the important function that the environment plays in underpinning development. It is cognizant that achieving Vision 2030 depends on maintaining the natural systems that support agriculture, energy supplies, and livelihood strategies. Kenya aims to provide its citizens with a clean, secure, and sustainable environment by the year 2030. To achieve this, the nation has set goals such as increasing forest cover from less than three per cent of its land base at present to four per cent by 2012 and to lessen by half all environment related diseases by the same time (Kenya Vision 2030, 2007).

The amount of land available to each person in Kenya has decreased from 9.6 ha in 1950 to 1.7 ha in 2005. It is projected that available land will further decline to 0.3 ha per person. Among the strategies for achieving these goals are: promoting environmental conservation to help achieve the Millennium Development Goals (MDGs); improving resource management especially soil quality and fertility to promote food production through the design and application of economic incentives; and commissioning public-private partnerships (PPPs) for improved efficiency in water and food security. Kenya will enhance disaster preparedness in all disaster-prone areas and improve the capacity for adaptation to the impacts of global climate change, and harmonize environment-related laws for better environmental planning and governance (GoK 2008).

2.4 Theoretical Framework

Marginal Zone Theory

Lewis Binford and Kent Flannery (2005), these scholars explain the emergence of agriculture as response to cyclical population pressure on the edges of the Nuclear Zones. This is a systemic theory that focuses on the relationship between population pressure, environment and subsistence strategies.

The theory assumes that human groups normally exist in balanced equilibrium with their physical environment. They don't normally intensify their food supplies and live normally in a state of systemic balance where change is the exception. Thus they keep their numbers below the carrying capacity of their food resources.

This development forced migration into areas of less optimum food resources the Hilly Flanks or Marginal Zones. This overpopulation created systemic imbalance in these zones where there were inadequate wild food resources for the expanded populations. The invention of agriculture occurred in these regions to recover systemic equilibrium at a different subsistence/ organizational level.

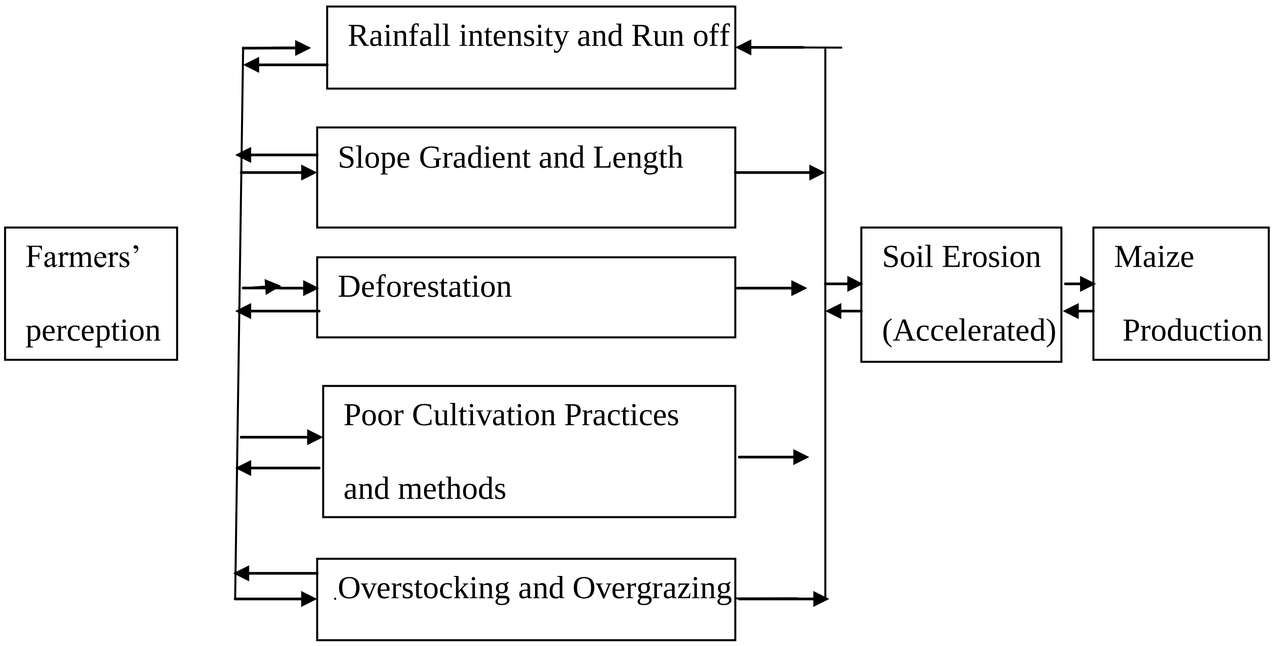
2.5 Critique of Literature

The data generally show coincidence with what is expected in relation to farmers' views on soil erosion, the impact of droughts, or climatic changes. However, several factors influence crop production in any given area and year. The most include the amount and distribution of rainfall and the degree to which water conservation is practiced; the price to be obtained for the output relative to other feasible crops; the varieties and quality of seeds used and their availability as an annual crop; the activities of the extension services; and the price and availability of fertilizers and other chemical inputs. Noted again is that the productivity-erosion relationship is not universal because the rate of change in marginal productivity losses will not be constant across different soils, crops, topography and climates.

2.6 Conceptual Framework

A conceptual framework is a translation of research variables and the relationship between them into a visual picture to illustrate the interconnections between the independent, intervening and dependent variables (Kothari, 2003). The conceptual framework for this study views farmers' perception as the independent variable while maize yield is the dependent variable whereas rainfall intensity and run-off, deforestation, slope gradient and length, vegetative cover, soil erodibility, overstocking/overgrazing, poor tillage/cultivation practices, and cultivation of marginal areas are the intervening or moderating variables linking independent variables to the dependent variable of the study .The framework attempts to show how these variables interrelate in the attainment of maximum maize yield through the understanding of the characteristics of soil erosion, factors influencing soil erosion and the adoption of soil and water conservation measures as stated by Zilberman, Feder , Just, (2012) as shown in figure 2.3 below:

Independent variable **Moderating Variables** **Dependent variable**



(Source: Author, 2014)

Figure 2.2: Conceptual Framework

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The study strove to assess farmers' perceptions on the impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County. Specifically this chapter discusses research design of the study with the aim to appraise farmers' knowledge of soil erosion, establish its causes and effects and investigate the existing soil and water conservation measures. This chapter thus presented the research design and the methodological procedures that were used to carry out the study. It entails the research design, target population and sample size, sampling procedures and techniques, instrumentation and data source, data collection procedures, data analysis, ethical considerations and a summary of chapter three.

3.2 Research Design

Frankfort and Nachmias (2005) defines research design as the blue print that enables the investigator to come up with solutions to observe problems and guides him or her in the various stages of the research. Orodho (2003) defines it as the scheme, outline or plan that is used to generate answers to research problems. This study was guided by a descriptive survey design. The design was chosen because it would enable the researcher to establish and describe the state of affairs as it exists at the time of study (Kothari, 2009).

According to Neuman (2006), descriptive surveys are quantitative instruments that produce information that is inherently statistical in nature, ask many people (respondents) about their beliefs, opinions, characteristics and past or present behavior. The study employed the survey design in order to generate precise information and make conclusive results regarding farmers' knowledge of soil erosion, the factors influencing its occurrence and the impacts on maize production. Since survey could be descriptive, exploratory, or involves advanced statistical analysis the researcher used mixed methods approach (both qualitative and quantitative strategies) so as to maximize the strengths and minimize the limitations of each approach. Qualitative research seeks to describe and analyze the culture and behaviour of humans and their groups from the point of view of those being studied (Wolcott, 1994).

3.3 Target Population and Sample Size

Population refers to a group of people, study subjects or objects which are similar (Homogenous) in one or more ways and which form the subject of study in a particular survey (Nachmias and Nachmias, 2005). The population in this study was all people aged 18years and above, living in Soy Division between October 20th and November 10th 2014. Kothari (2003) defines sample size as the number of items selected from the universe to constitute a sample. He notes that the size of a sample should be optimum; one which fulfils the requirements of efficiency, representativeness, reliability and flexibility.

The study area had a total population of 26,237 (N=26,237) that translates to a target population of 5,993 farmers/ households that cut across the five locations and spread in the seventeen sub-locations of the division (Republic of Kenya, Statistical Abstract, 2009). The informants included four (n=4) government officers from the Ministries of Agriculture, Water, Livestock and Environment, six officials (n=6) from

Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs), and five (n=5) chiefs. A sample is a finite part of a statistical population whose properties are studied to gain information about the whole (Keith, 2004). Therefore the total sample size was 135 respondents. Neuman, (2006) states that a sample size of a study is considered adequate so long as it is large enough to allow for reliable analysis for cross-tabulation and provide desired level of accuracy in estimates of the larger population. The following is the breakdown of the target population alongside the sample size as shown in table 3.2 below:-

Table 3.1 Sample Size

Categories of Respondents	**Target Population**	**Sample Size**
1. Farmers /household heads in Soy Division	5993 * 2 %	120
2. Government Official- ministries of Agriculture, livestock, Environmental and Water.	4	4
3. Chiefs	5	5
4. Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs)	22	6
Total population and respondents	5,993	135

The study area was selected after considering factors such as accessibility, perennial problems of soil erosion and the significance of the study information to the farmers, local communities and other stakeholders. Therefore it was expected that this target population would provide the required sample size that was large enough to represent the salient characteristics of the accessible population for the study.

3.4 Sampling Procedure and Techniques

Sampling is any way or system of selecting a subset from the entire set of entities of interest or population that result to a sample. Kothari (2003) defines sampling as the selection of part of an aggregate or totality on the basis of which a judgment or inference about the aggregate is made. The research used Probability proportional to cluster size (PPS) sampling technique to select the sample. In the first stage, the overall population of Soy Division was divided into five locations according to the geographical situation of the study area, (n = 5). This would ensure proper identification of subjects with similar characteristics (homogeneity) in the population and thus appropriate representativeness in the sample. In the second stage, the population was clustered into seventeen units which are the sub-locations of the division, (n=17). With the assistance of area assistant chiefs and research assistants, simple random sampling was employed to select farmers/households representatives in each cluster (sub-location) to form the sample by listing all households and assigning them numbers written on papers that are folded and put in a container, shaken to ensure proper mixing then picked one after another randomly to eliminate bias. According to Peter Bacchetti *et al* (2009), the smallest sample size that minimizes total study cost divided by sample size, i.e., the cost per subject therefore only 2% of the target population was selected proportionally (2% * 5993= 120) to arrive at 120 respondents who were interviewed as shown in table 3.2.

Finally, non-probability sampling, particularly purposive sampling was used to select fifteen informants comprising four government officers; one from each of the Ministries of Agriculture, Water, Livestock, Environment and three representatives from Non-Governmental Organizations and three from Community Based Organizations, and five area chiefs, who were also interviewed. Purposive sampling was preferred for this category of respondents as workers who interact with farmers and some are residence in the area of study with farming experience.

Table 3.2: Sampling Procedure

Location	Soy Division Total population 26,237		Target population Households/Farmers	Sample population 2%
1	Chemoibon Location	5,351	1,180	24
	Chepsirei	1,024	216	4
	- Koimur	1,578	356	7
	-Tumeiyo	2,749	608	12
2.	Soy location	10,391	2,463	49
	Kapsokom	1,102	245	5
	-Turesia	3041	660	13
	-Chop	1,300	387	8
	-Morop	2,088	517	10
	- Muskut	1,459	340	7
	-Sego	1,401	314	6
3.	Kibargoi Location	5,202	1,153	23
	-Chang'ach	1,261	262	5
	- Cheptebo	1,648	355	7
	-Emsea	1,220	284	6
	- Rokocho	1,073	252	5
4.	Epke Location	2,464	588	12
	-Chepsigot	1,308	355	7
	-Epke	1,156	233	5
5.	Chepsigot Location	2,829	609	12
	-Kabito	1,723	393	8
	-Chebinyiny	1,106	216	4
Total		26,237	5,993	120

(Source: County Planning and National Statistics; Iten, 2014)

3.4 Instrumentation and Data Source

This involves the techniques adopted by the researcher in the data gathering phase of the work. The study generated data from primary and secondary sources. Primary data was sourced through structured and unstructured questionnaires, and observation checklists. It was collected on variables on personal and background information; age of respondents, gender, educational qualifications, residential area of respondents, length of stay in the region and data related to other aspects of the study as guided by the research objectives. Secondary sources in document analysis included internet, textbooks, government publications, journals and other published sources: newspapers and environmental magazines, and unpublished sources, including libraries, archives and government offices. This provided a better understanding of the research problem and findings. The data was recorded using mapping, tabulation, sketching, note taking and photographing.

3.4.1 Questionnaires

A total of one hundred and twenty (120) structured questionnaires were randomly administered on face-to-face interviews by research assistants to a hundred and twenty (120) respondents who were farmer residents. The questionnaires probed the farmers' knowledge of soil erosion and its characteristics, the factors influencing soil erosion, the effects of soil erosion on maize production, the existing soil and water conservation methods and suggestions for appropriate mitigation methods as well as ways of improving maize production. The researcher ensured that all the questions in the questionnaire were related to the objectives of the study.

3.4.2 Interview Guide

Unstructured interviews were employed in this study; as means of collecting data for a statistical survey. According to Ogula (2005), an interview is a conversation which allows the interviewer to probe and get the feelings of the respondents. Though it is a slow instrument, it was used to curb subjectivity paused by the questionnaires. The interview questions contained one section, which had specific information which contained the specific objectives of the study.

Fifteen Unstructured interview schedules were administered to fifteen key informants who were government officials one from each ministry: Agriculture, Water, Livestock and Environment, six from CBOs and NGOs, and five chiefs; one from each location of the study area. This was done on face-to-face interview to verify the reliability of the information gathered by the questionnaires and were intended to seek in-depth information. The approach creates confidence on the part of the respondents thus results to more reliable, valid and objective results. These subjected respondents to the same stimuli thus ask each informant similar questions (Kombo and Tromp 2009). Since it involved survey design, it ensured the reliability of the gathered information was systematic, in-depth and time-saving

3.4.3 Observation Checklist

Observation is a suitable technique especially in ascertaining facts drawn from the respondents; provides a basis to confirm or justify some issues that may not have been clearly understood by either party in the survey. This technique further minimizes chances of recording incorrect data. Observation indicators are useful for evaluation of physical condition. It enabled the researcher to observe and record the nature and type of soils and soil erosion, vegetation cover, estimate steepness and lengths of slopes and the general landscape features of the study area. The observation method was used to verify and determine the extent of the effects of soil erosion, the peoples' specific behaviour patterns and trends of maize production. The checklist was intended to cross-check the strength of the information given by the respondents, make sketches of land use patterns and photographs taken where applicable (Kothari, 2003).

3.4.4 Document Analysis.

This is critical examination of records containing information on the items related to effects of soil erosion on production of maize in the study area. The first step was to use NEMA and Kenya Ministry of Agriculture search engine which covers several databases of soil erosion and land degradation, soil and water conservation and deforestation information. The second step was to consult Google Scholar (http://scholar.google.com) which covers more publications, internet involving web sites/home pages and through personal e-mail accounts, textbooks, government publications, journals, libraries, archives, newspapers and magazines published and unpublished sources; libraries and government offices. Searched terms used included farmers’ perception, views, and awareness, opinion of soil erosion and effects of soil erosion on crop productivity. The information sought was both qualitative and quantitative to critically examine recorded information related to the issue under investigation.

3.5 Validity and Reliability Tests of Research Instrument

3.5.1 Validity Test

Validity is the degree to which results obtained from analysis of the data actually represent the phenomenon under study. It is the accuracy and meaningfulness of conclusions which are based on the research results; the agreement between the value of a measurement and its true value, quantified by comparing measurements with values that are as close to the true values as possible (Argyrous, 1996). Proper validity ensures the precision of a single measurement and improves the ability to characterize relationships between variables in descriptive studies. In order to ascertain validity of the research instrument the researcher used pilot survey and distributed ten questionnaires to ten members in the study area. The results of the piloted questionnaires enabled the researcher to determine the consistency of responses to be made by respondents and revised the document by adjusting the items accordingly.

3.5.2 Reliability Test

Reliability is the measure of the degree to which a research result yields consistent results of data after repeated trials (Mugenda & Mugenda, 1999). It is the degree of consistency that the instrument or procedure demonstrates. Reliability refers to the reproducibility of a result by taking several measurements on the same subjects to improve the ability to track changes in measurements in descriptive survey study. The Test-Retest technique was used through the development of questionnaires and administered to the same group of subjects after a period of two weeks to ensure reliability of the study results (Orodho, 2005).

3.6 Data Collection and Procedures

The researcher proceeded to collect data from the selected respondents after acquiring a Research Clearance Permit from the National Council for Science and Technology and receiving permission from the Department of Geography, Moi University. Prior to the visit permission was also sought from the Provincial Administration, the D.C's office Keiyo South District and the D.O's office Soy Division, who notified the Chiefs of all the five Locations and their Assistants of the researcher's visit. The researcher visited the study area before hand for familiarization and acquaintance with the targeted respondents, especially the officers from the various ministries. During this visit, the researcher informed the Chiefs, Assistant Chiefs and all the informants about the purpose of the intended study and booked appointments for data collection. Data was collected from the respondents using questionnaires and interview schedules while observation checklist was used to verify the information, and photographs were taken where appropriate.

3.7 Data Analysis and Presentation

Mugenda and Mugenda (2003) define analysis as categorization, ordering manipulating answers, summarizing of data to obtain answers to the research questions. Since this is a combined qualitative and quantitative research the data collected was analyzed using narrative technique and descriptive statistics including frequencies, means and percentages. The data was presented using frequency distribution tables and diagrams: bar graphs and pie charts. The main goal of this research was to describe the variables of the problem of study and make conclusions and recommendations based on the study findings.

3.8 Ethical Considerations

Kombo and Tromp, (2006) noted that researchers whose subjects are people or animals must consider the conduct of their research and give attention to the ethical issues associated with the carrying out of their research. This study deals with people therefore the researcher and research assistants assured the respondents of privacy and confidentiality by explaining to them the purpose of the study and guaranteed them freedom of withdrawal from the study especially on circumstances beyond their control. Participation in research is voluntary thus the researcher explained to the respondents the importance of the study and humbly requested them to willingly participate in it by giving relevant and honest information. The researcher and research assistants developed a good rapport with participants by being frank in answering questions. The researcher ensured the respect of individual rights' to safeguard their personal integrity was adhered to by being objective in asking and answering questions. Anonymity was also protected by numbering questionnaires for purposes of data identification during data analysis.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter focused on data analysis, presentation, interpretation and discussion of the findings of the study. The study examined farmers' knowledge of soil erosion, assessed factors that influence soil erosion, explored farmers perceived impacts of soil erosion on maize production and assessed the existing soil erosion mitigation measures in Soy Division Elgeiyo-Marakwet County. Descriptive statistics were used to analyze responses from respondents who were farmers or household heads. The information collected from government officials, NGOs and CBOs and Chiefs have been analyzed through narrative technique and discussed separately to facilitate comparisons, contrasts, generalization and conclusions.

4.2 Response Rate

Initially the study sampled population was 120 respondents, however only 108 questionnaires were returned, fully filled and free from errors, this gave a response rate of 90%. According to Mugenda and Mugenda (2003), a response rate of 50% is adequate for analysis and reporting, 60% is good and over 70% is very good in a descriptive study. They assert that a researcher should use all means available to increase response rate to have a representative sample for meaningful generalizations.

Table 4.1: Response Rate

Category	Frequency	Percentage
Returned	120	100 %
Not returned	12	10%
Total	**108**	**90**

Source :(Researcher, 2015)

4.3 Demographic and Socio –Economic Characteristics of the respondents

This research examined the respondents' demographic and socio-economic characteristics including gender, age, and level of education, family size, and length of stay in the area of study in years and livelihood or occupation. Data analyzed was based in various forms such as numbers, levels and categories. The numeric data was analyzed through the use of descriptive statistics and the output was then presented in tables, bar graphs and pie charts.

4.3.1 Gender of the Respondents

The study intended to interview both male and female respondents to identify any variation in gender roles in agricultural activities; however there were high male respondents as compared to the females who were 77 (71.3%) and 31(28.7%) respectively. This evidently indicated that the respondents were mainly males who were actively engaged in farming. It is also possible that the word 'household head' could have been taken to mean the man of the family so that where the researcher and assistants met both husband and wife, the man had to be interviewed as the family head. The study findings on the gender of household heads are shown in table 4.1 below:

Table 4.2 Gender of respondents

Gender	Frequency	Percent	Valid Percent
Male	77	71.3	71.3
Female	31	28.7	28.7
Total	108	100.0	100.0

4.3.2 Age of the Respondents

The age of the respondents was probed to determine their experiences on soil erosion phenomenon. From the findings majority of the respondents were of the age category of 36-45years, 46-55 years and 26-35 years who were 46(42.6%), 23(21.3%) and 19(17.6%) respectively. This indicates that most of the respondents were middle aged and energetic residents who could engage in farming and possibly mature and settled in family life thus involved in feeding their families and perhaps struggling to get a surplus for sale. However, the respondents in the age category of 56-65 and 66 and above years above were 12(11.1%) and only 3(2.7%) implying that this group is no longer actively engaged in farming due to their advancing age, aloofness or inaccessibility to farming activities. Further, those of age category of 18-25 years were only 5(4.6 %). These are young people who were hardly found at home during the study period probably because they were in school, college or were out at work or searching for employment. These findings are summarized in figure 4.1below:

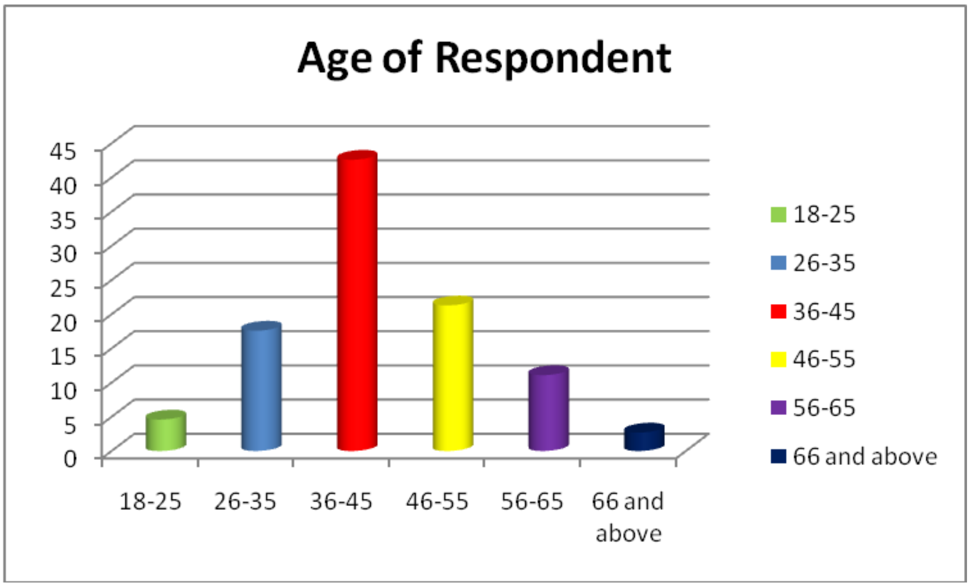


Figure 4.1 Age of the Respondents

4.3.3 Education Level of the Respondents

The study sought to investigate the level of education of respondents to assess their knowledge of soil erosion and its characteristics. The respondents were categorized into groups of illiterate, primary, secondary, college and university levels. The research revealed that majority of the respondents' attained secondary and primary school education who were 45 (41.7%) and 36 (33.3%), followed by college graduates at 21 (19.4%). These results show that majority of the respondents were educated and hence were knowledgeable of the concept of soil erosion, their causes and effects thus could provide relevant information to the study. The illiterate and the university categories were 5 and 2 respondents respectively at 4.6% and 1.9 % in that order. The study findings are summarized in figure 4.2 below:

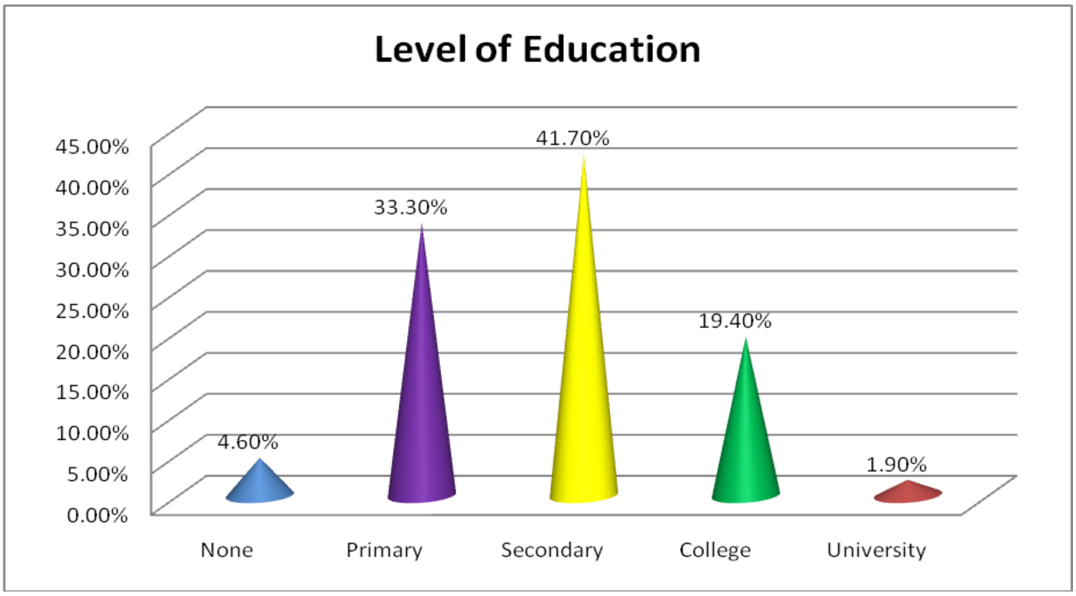


Figure 4.2 Level of Education of Respondents

4.3.4 Family size of respondents

The research endeavored to find out about family size of respondents to verify their food needs in relation to its production and soil erosion. This was categorized in intervals of five and majority of respondents who were 47 (43.5 %) had family members between 6-10 while 34 (31.5%) respondents acknowledged having a family size of 1-5. Those with family sizes of 11-15 and 16-20 were 15 (13.9%) and 9(8.3%) accordingly whereas respondents with 21 and above members were only 3 which was 2.8%. The findings showed that majority of the respondents had large and moderate family sizes that required large amount of food that would compel family heads to engage more in farming activities especially maize cultivation to enable them feed the large families and possibly remain with a surplus for income to meet other needs such as school fees. The results are as shown below:

Table 4.3 Family size of respondents

No. of family members	Frequency	Percent
1-5	34	31.5
6-10	47	43.5
11-15	15	13.9
16-20	9	8.3
21 and above	3	2.8
Total	108	100.0

4.3.5 Length of stay in the area of study in years

The research explored the length of stay of respondents in their current location in intervals of fifteen years to verify their experience in agricultural activities and soil erosion. Findings indicated that majority of the respondents fell in the category 31-45 years who were 43; 39.8.0%. The second group was 16-30 years who were 26; 24.1% respondents. Other groups were 46-60 years who were 19; 17.6%, while those below 15 years were 13; 12.0% and those above 60 years were 7 and translated to 6.5% as shown in table 4.4 below:

Table 4.4 Length of Stay in Years of Respondents in the area of study in years

Length of Stay in the Location		Frequency	Percent
Valid	Below 15	13	12.0
	16-30	26	24.1
	31-45	43	39.8
	46-60	19	17.6
	60 and above	7	6.5
	Total	108	100.0

4.3.6 Livelihood/Occupation

The research probed the specific source of livelihood of the respondents to ascertain their interaction with the environment and specifically their pieces of land in an endeavor to feed their families and earn income through agricultural activities particularly maize cultivation. The findings indicated that majority of the respondents practiced mixed farming who were 55; 50.9% and evident that the residents grew crops and kept animals which could provide manure and income for purchase of farm inputs such as inorganic/chemical fertilizers, seeds and labour and in return improve soil fertility and maize yield subsequently. Those involved in business were 21; 19.4% and the employed in government and companies including Kimwarer Fluorspar Company were 10; 9.3%while those engaged in crop farming were 16; 14.8%. The respondents who were purely pastoralists were 6; 5.6%.

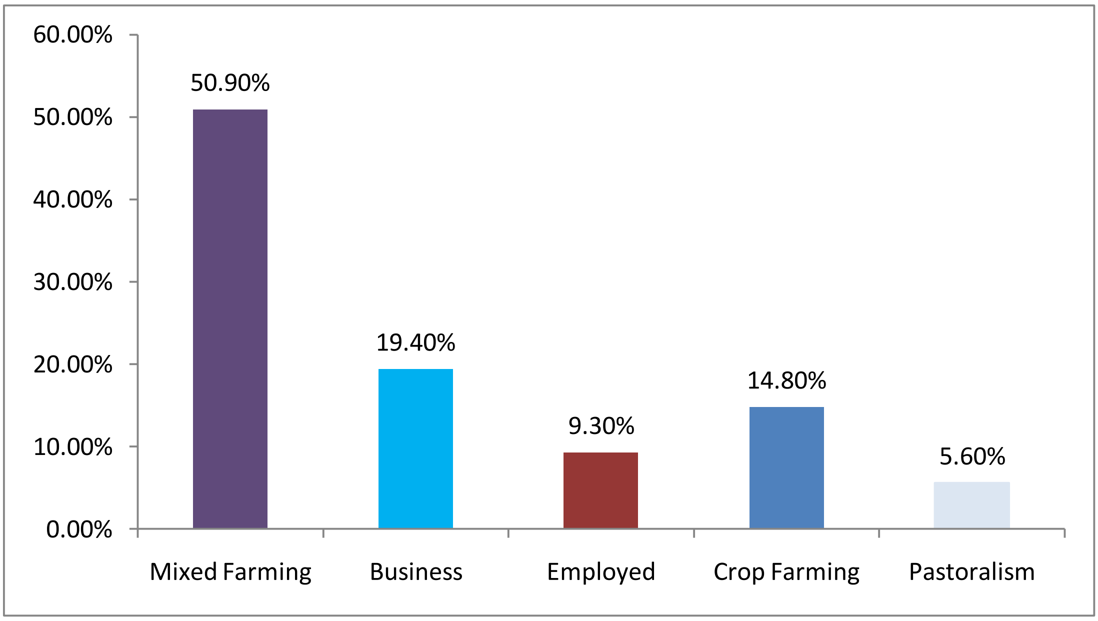


Figure 4.3 Occupation/Livelihood of respondents

4.4 Land Tenure and land use

The study looked into land tenure system in an effort to appraise farmers' attitudes and perceptions towards maize yield in relation to land ownership and soil and water conservation measures. The figure below shows that majority of the respondents who were 51 (47.2%) owned land communally while 39(36.1%) respondents owned land privately and 18(16.7%) respondents depended on leased land. The findings illustrated that most land is owned communally thus it was possible that farmers were not keen to invest in consistent and permanent soil conservation measures in fields that could not guarantee permanent ownership and subsequent maize yield improvement. However, some farmers leased land especially in virgin lands in an effort to improve maize yields well as owning land both communally and privately. This implies that, the communally owned land experienced more soil erosion that had and affect on maize production.

Table 4.5 Land tenure system in the area of study

Land Tenure system	Frequency	Percentage
Leasehold	18	16.7
Communal	51	47.2
Private	39	36.1
Total	108	100.0

4.4.1 Total land size owned in hectares

The study sought to find out the total land size owned in hectares by farmers in the study area to establish agricultural activities and land usage or utility in relation to maize production. The results were 45(41.7%) of total respondents owned less than five hectares while 27(25.0%) owned 6-10 hectares of land whereas 19(17.6%) of respondents affirmed owning 11-15 hectares of land. Other 13(12.1%) of respondents stated owning 16- 20 hectares while those owning 21 and above hectares of land were 4(3.7%) of respondents as depicted in table 4.6 below:

Table 4.6 Total land size owned in hectares

Total Land Size In Hectares	Frequency	Percentage
Below 5 years	45	41.7
6-10	27	25.0
11-15	19	17.6
16-20	13	12.0
21 and above	4	3.7
Total	108	100.0

4.4.2 Types of Crops Grown

The research probed the types of crops grown in the area of study to attest relations of soil erosion and crop yield. The results were that 87(80.6%) respondents indicated that they grew maize intercropped with beans for the purpose of subsistence and occasionally sell the surplus especially when harvest was good due to adequate rains whereas 18(16.7%) respondents grew millet and only 3(2.8%) grew other crops including sorghum as well as fruits; mangoes and bananas to supplement diet as depicted in figure 4.5 below. The findings demonstrated that majority of the respondents till maize as their staple food crop hence could provide appropriate data relating soil erosion to maize yield.

4.4.3 Types of Animals Reared

The study investigated the type of animals reared in the area of study to strive to relate it to the occurrence of soil erosion phenomenon. The results revealed that 71(65.7%) respondents kept cattle and particularly zebu type, 26 (24.1%) disclosed owning goats, 15(13.9%) of the respondents divulged to have sheep and the rest, 6(5.6%) did not have any animal. However, 23(21.3%) of the total respondents confessed owning both cattle and goats. The findings indicate that most farmers kept cattle and a significant number reared only goats as part of their livelihood in form of food and income. It was also apparent that the number of animals reared was moderate hence could not be considered as a serious factor of soil erosion in the area of study.

4.5.1 Farmers’ Knowledge of Soil Erosion

The research investigated the farmers’ knowledge of soil erosion through the following sub-headings: definition of the concept, ‘soil erosion’, extent and intensity of soil erosion, its occurrence, indicators or signs and types of soil erosion experienced in the area of study.

4.5.1.1 The concept ‘soil erosion’

Respondents were asked to define the term ‘soil erosion’ in their own words, and these were their specific responses: ‘ transport of soil from land; carrying away of soil by rain water; washing away of top soil to river valleys; carrying away of top soil by running water causing gullies and rills; loss of soil through rainfall runoff; rainfall water carrying soils off the maize crop land, removal of top soil by agents like running water, animals, wind and/or man; and losing soil through rain water movement downstream to rivers or lakes. Others included the corrosion of top soil by animals, wind or water on sloping areas; and transport of soil particles by rainfall/water runoff.

4.5.1.2 Occurrence of Soil Erosion

Respondents were asked to indicate whether soil erosion occurs in their lands and/or their neighborhoods and their responses were as shown in table 4.8 and 76(70.4%) of total respondents affirmed, while 23(21.3%) refuted and 9(8.3%) did not have an idea about soil erosion. The findings indicated that majority of respondents were aware and knowledgeable of the occurrence of soil erosion in their areas of residence thus could also be aware of its effects on maize yield.

Table 4.7 Occurrence of Soil Erosion

Occurrence of soil erosion		Frequency	Percent
	Yes	76	70.4
	No	23	21.3
	Don’t know	9	8.3
	Total	**108**	**100.0**

4.5.1.3 Type of Soil Erosion

Respondents were required to indicate the type of soil erosion and the extent of severity that is experienced in their lands and neighborhoods and majority of them pointed out rill erosion as very severe as supported by 38.1% of respondents while 24.1% said it was moderate and 17.6% felt it was severe. A significant number which was 13.9% said it was slight and a few, 6.3% thought it was not happening at all.

Table 4.8 Type of Soil Erosion and the Extent of Severity

Erosion type	very severe%	severe%	moderate%	mild/slight%	not at all %
Splash	12.0	25.0	38.9	19.4	4.6
Sheet	28.7	35.2	23.1	10.2	2.8
Rill	38.1	17.6	24.1	13.9	6.3
Gully	25.0	45.4	15.7	11.1	2.8

Most respondents declared splash erosion as moderate as confirmed by 38.9%, while 25.0% felt it was severe, 12.0% saw it as very severe whereas 4.6% stated that it was not occurring. Sheet erosion was supported by 35.2% of respondents as being severe whereas 28.7% felt it was very severe. Another 23.1% of respondents said it was moderate then 10.2% and 2.8% indicated and refuted its occurrence respectively. Gully erosion was affirmed by 45.4% of respondents as being severe, 25.0% said it was very severe, 15.7% acknowledged that it was moderate while 11.1% avowed that it was mild or slight and 2.8% refuted it. From the above finding it can be seen that the most common type of soil erosion that had affected Soy Division in Elgeyo Marakwet County was sheet erosion.

4.5.1.4 Indicators/Signs of Soil Erosion

Respondents were required to indicate indicators/signs of soil erosion and the findings are summarized in table 4.10 below:-

Table 4.9 Indicators/Signs of Soil Erosion

Indicator/signs	Very severe %	Severe %	Moderate %	Mild/slight%	Not at all %
Root exposure	48.9	17.5	18.4	12.9	1.3
Splash particles on objects/leaves	22.2	36.6	26.4	11.1	3.7
Sheet wash	25.9	34.1	28.6	9.5	1.9
Red soil/change of color	21.4	37.5	25.8	13.9	1.4
Rill	47.9	21.6	19.5	8.2	2.8
Stoniness	39.1	19.7	27.9	10.8	1.5

The research inquired from the respondents about the signs or indicators of soil erosion to which majority of the respondents who were 48.9% stated that root exposure was very severe, 17.5 % said it was severe while 18.4% affirmed that it was moderate whereas 12.9% avowed that it was mild or slight as 1.3%of respondents nullified its occurrence. Rill erosion was acknowledged by 47.9% of respondents as being very severe, 21.6% confirmed that it was severe while 19.5% said it was moderate as 8.2% stated that it was mild or slight whereas 2.8% refuted its occurrence. Stoniness as erosion sign was supported by 39.1% of respondents as being very severe, while 19.7% indicated severe whereas 27.9%asserted that it was moderate while 10.8% and 1.5% respondents declared that it was mild and not occurring respectively.

4.5.2 Causes of Soil Erosion

The study sought to identify the causes of soil erosion and the findings are illustrated in figure 4.6 below:

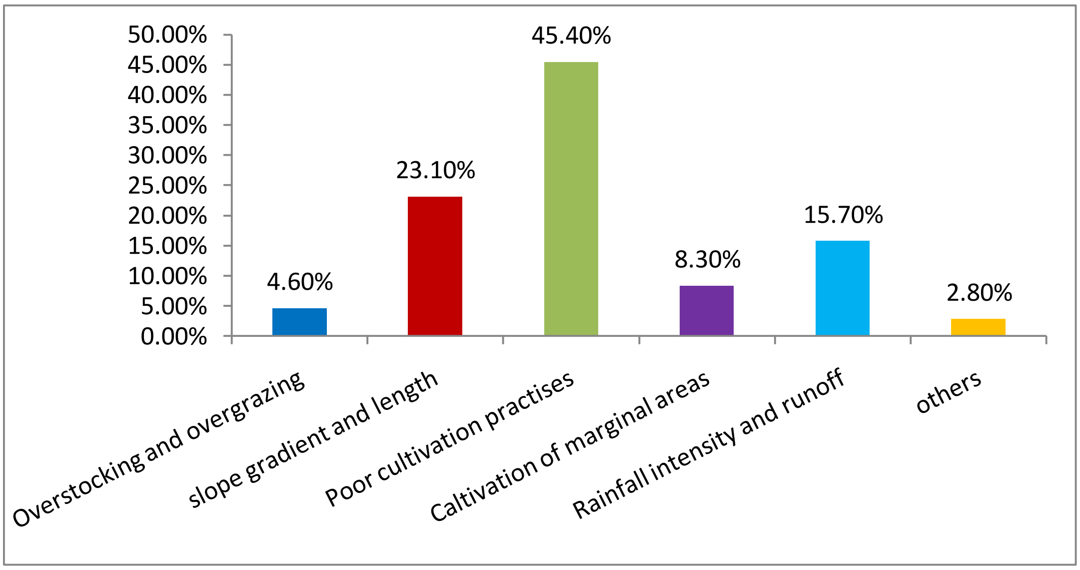


Figure 4.4 Causes of Soil Erosion

Majority of the respondents who were 39 (36.1%) attributed it to poor cultivation practices while 25(23.1%) mentioned slope gradient and length whereas 18(16.7%) cited rainfall intensity and runoff. Another 14(13.0%) acknowledged cultivation of marginal areas,7(7.6%) affirmed overstocking and overgrazing, and the rest 5(5.4 %) respondents stated the cutting of trees (deforestation), population growth, drought, soil erodability, cultivation of river banks and cultivation of catchment areas as the causes of soil erosion.

4.5.3 Impact of Soil Erosion on Maize Production

The research investigated the impact of soil erosion on maize yield through assessment of issues such as trend of maize production and reasons for the trend of maize production and on-site and off-site effects of soil erosion on maize yields.

4.5.3.1 Trend of Maize Production

The study probed the trend of maize production in the area of study from the year 2010 to 2014 as per records in the ministry of agriculture (DAO, Chepkorio, 2014) and the results showed that majority of the respondents, 79(73.1%) confirmed that maize production was decreasing while, 24(22.2%) said it was maintaining and only 5(4.6%) stated that it was increasing as shown in the figure 4.5 below:

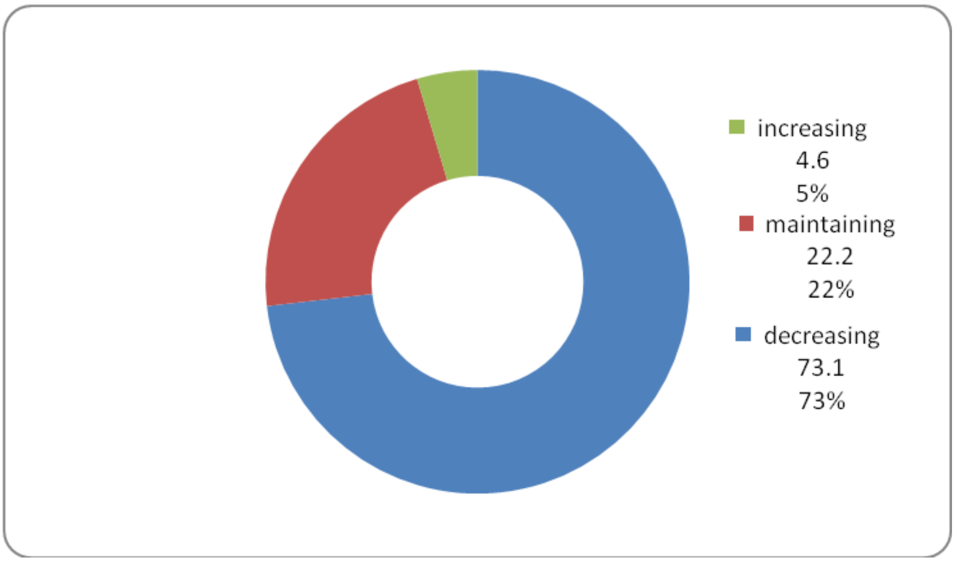


Figure 4.5 Trend of Maize Production

4.5.3.2 Reasons for the Trend of Maize Production

The reasons for the trend of maize yield were also looked into with the findings showing 41(38.0%) respondents blaming inadequate rainfall, 25(23.2%) declared soil erosion as the cause and 16(14.8%) attributed it to diseases while 13(12.1%) of respondents avowed that the non-usage of chemical fertilizers was the reason. Other respondents, 9(8.3%) stated nutrient depletion through leaching as the cause while 4(3.7%) of total respondents blamed non-use of manure. This implies that the farmers perceived that rainfall consistency was the main cause of maize reduction, and consequently soil erosion was their second factor of maize reduction. The rains fell in a short period and heavy that caused serious soil erosion and eventually affecting maize production shown below in table 4.10 below:

Table 4.10: Reasons for the Trend of Maize Production

Reason for the trend of maize production	Freq	Percentage
Low rainfall	41	38
Soil erosion	25	23.2
Diseases	16	14.8
Low inputs	13	12.1
Loss of nutrients	9	8.3
	4	3.7
Totals	**108**	**100.0**

4.5.3.3 On-Site and Off-Site Effects of Soil Erosion on Maize Yield

The research investigated on-site and off-site effects of soil erosion on maize yield in the study area and the responses are summarized in tables 4.11 and 4.12 below;

Table 4.11 On-site effects of soil erosion on maize production

On-site Effects	SA	A	NS	D	SD
-Removal of valuable top soil leads to reduced maize yield	54.3	19.8	15.1	8.2	2.6
-Loss of organic matter/residues and applied manure off field leads to reduced maize yield	34.2	46.1	14.9	9.7	1.1
-Disturbance/destruction of maize seeds and plants leads to reduced maize yield	31.8	38.7	19.4	7.2	2.9
-Stunted growth on maize seeds and plants due to lack of adequate nutrition and fertilizer loss leads to reduced maize yield	29.9	45.6	9.1	13.9	1.5
-Slow/delay seed crop emergence leads to reduced maize yield	24.7	37.3	19.7	16.5	1.8

4.5.3.4 Off-site effects of soil erosion on maize production

Table 4.12 Off-site effects of soil erosion on maize production

Off-site effects of soil erosion	SA	A	NS	D	SD
-Eroded soil deposited down slope, destroy maize seeds and plants that leads to reduced maize yields	47.1	28.5	16.4	6.6	1.4
-Eroded and deposited soil bury small seedlings that leads to decreased maize yield	45.1	27.6	13.2	11.8	2.5
-Eroded and deposited soil inhibits or delays seed emergence that leads to decreased maize yield	29.7	37.9	20.4	8.2	2.8

The views of farmers/household heads were sought to find out the perceived effects of soil erosion on maize production. Majority of the respondents, 54.3% strongly agreed with the idea that the removal of valuable top soil leads to reduced maize yield and 19.8% agreed. While 15.1% of respondents were not sure, 8.2% disagreed and 2.6% strongly disagreed. Followed by loss of organic matter/residues and applied manure off field leads to reduced maize yield where most respondents who were 34.2% strongly agreed and 46.1% agreed. Nevertheless, 14.9% were not sure whereas 9.7% disagreed and 1.1% strongly disagreed. In the third place was disturbance or destruction of maize seeds and plants leads to reduced maize yield which had 31.8% of respondents strongly agreeing and 38.7% agreed. However, 19.4% were not sure, while 7.2% disagreed and 2.9% strongly agreed. Fourthly, stunted growth of maize seeds and plants due to lack of adequate nutrition and fertilizer loss leads to reduced maize yield where 29.9% of respondents strongly agreed and 45.6% agreed. Nonetheless, 9.1% were not sure, whereas 13.9% disagreed and 1.5% strongly disagreed. Finally, slowed or delayed maize seed emergence (germination), leads to reduced maize yield had 24.7% of respondents strongly agreeing and 37.3% agreeing whereas 19.7% of respondents were not sure, 16.5% disagreed and 1.8% strongly disagreed.

From the above findings on on-site effects of soil erosion on maize production implies that loss of organic matter/residues and applied manure off field leads to reduced maize yield. This also can lead to stunted growth on maize seeds and plants due to lack of adequate nutrition and fertilizer loss leads to reduced maize yield.

On off-site effects of soil erosion on maize production, the statement; eroded soil carried destroys maize seeds down slope had 47.1% of respondents strongly agreeing as 28.5% agreed. While 16.4% of the respondents were not sure, 6.6% of respondents disagreed and 1.4% strongly disagreed. This was followed by the statement; eroded and deposited soil bury small seedlings leads to decreased maize yield was affirmed by 45.1% of respondents who strongly agreed while 27.6% agreed. Although 13.2% of respondents were not sure, 11.8% disagreed and 2.5% strongly disagreed. Most respondents, 29.7% strongly agreed with the fact that soil erosion inhibits/or delays maize seed emergence while 27.8% agreed. Whereas 20.4% respondents were not sure, 8.2% disagreed and 2.8% strongly disagreed.

Implication on off-site effects of soil erosion on maize production, on the perceived effects of soil erosion on maize production was that eroded soil deposited down slope, destroy maize seeds and plants that leads to reduced maize yields scored the highest.

4.5.4 Soil Erosion Mitigation Measures

4.5.4.1 Soil Conservation Methods

The research further investigated the mitigation methods and practices currently applied by farmers in an effort to curb erosion. The commonly mentioned soil erosion mitigation methods were terracing particularly channel terracing indicated by 37 respondents at 34.3% while 21(24%) respondents affirmed planting strips of grass (nappier). Whereas trash lining and soil bunds were declared by 14(16.7%) and 11(10.2%) respondents respectively, 8(7.4%) respondents stated soil bunds and 7(6.4%) of them mentioned bush fallowing. The rest 4(3.7 %) accredited tree planting and gully controls/gabions as the methods used in the area of study.

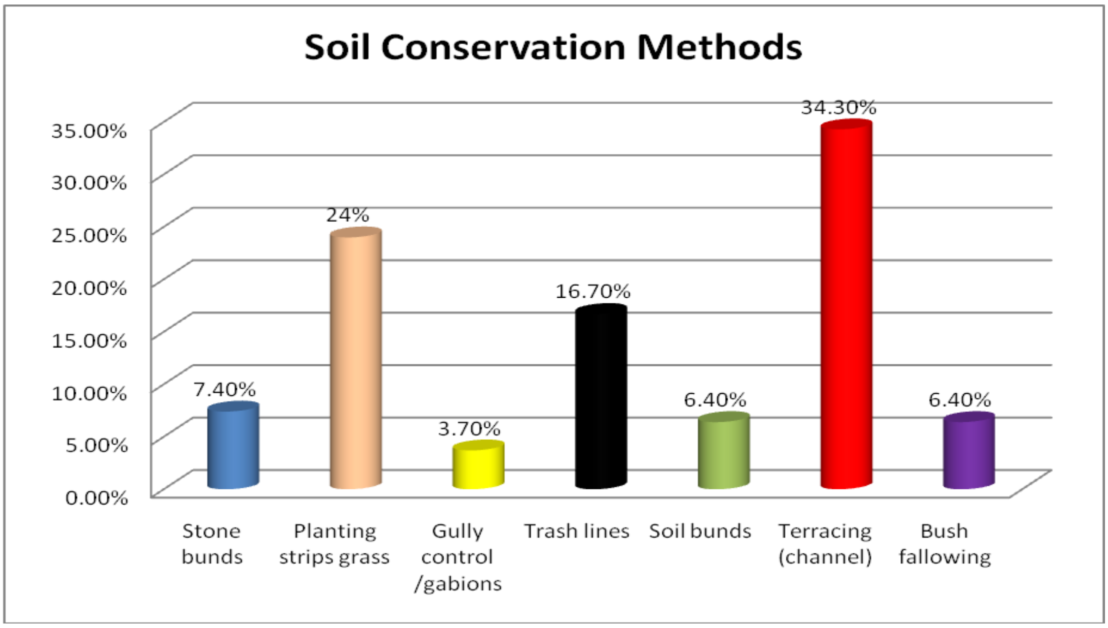


Figure 4.6 Farmers' views on Soil conservation methods

4.5.4.2 Soil Conservation Practices and Maize Yield Improvement

The research also investigated the soil conservation practices applied by farmers in the area of study to combat soil erosion and boost maize yield. The findings showed that intercropping or mixed cropping was approved by 49(45.4%) of respondents followed by cover crops indicated by 21(19.4%) of respondents and contour ploughing and planting indicated by 14(13.0%) respondents. Other significant methods mentioned were crop rotation avowed by 11(10.2%) respondents, 6(5.6%) approved the use of inorganic fertilizer and 4(3.7%) respondents said organic fertilizer was applied in the maize cultivation. The rest mentioned by 3(2.8%) respondents were minimum tillage, non-tillage, use of herbicides, listing/ridging and strip cropping as depicted in the table 4.13 below:

Table 4.13 Farmers' views on soil conservation practice and maize yield improvement

Ranking	Soil conservation practice	Frequency	Percentage
1	Use of organic fertilizer	4	3.7
2	Cover crops	21	19.4
3	Crop rotation	11	10.2
4	Contour ploughing and planting	14	13.0
5	Intercropping /mixed cropping	49	45.4
6	Use of inorganic fertilizer	6	5.6
Others	Minimum tillage, non tillage, use of herbicides, listing/ridging, strip cropping	3	2.8
Total		108	100

4.5.4.3 Accessibility to agricultural extension service on activities

(i) Accessibility to Agricultural Extension Service

The study explored availability of agricultural extension service to the farmers to which most respondents 85(78.7%) confirmed its provision while 23(21.3%) disapproved as shown in the table below:

Table 4.14 Farmers' views on Accessibility of Agricultural Extension Service

Accessibility to Agricultural Extension Service	Frequency	Percentage
Yes	85	78.7
No	23	21.3
Total	108	100

(ii) Period or Frequency of Accessibility of Agricultural Extension Service

The availability of agricultural extension service on agricultural activities including soil erosion was inquired from the respondents and majority 37(34.3%) specified accessibility on yearly basis, 25(23.1%) declared availability after six months while 19(17.6%) of respondents admitted getting it in three months period whereas 12(11.1%) disclosed monthly period, 6(5.6%) avowed availability in a period of two years, 5 respondents indicated availability on weekly basis and only 3 respondents confessed availability after a period of 5 years as shown below:

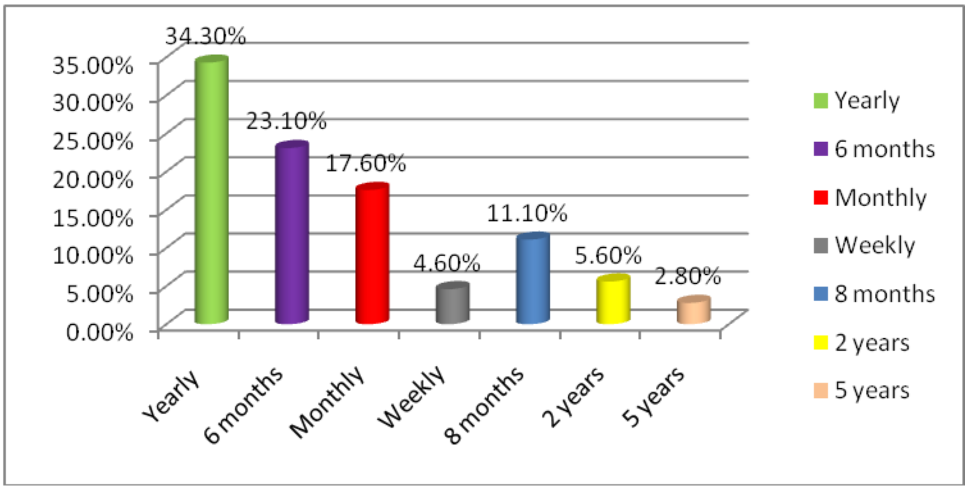


Figure 4.7 Farmers' views on frequency of accessibility of agricultural extension service

(iii) Level or stage of agricultural extension service to the farmers

Respondents were required to designate the stage of availability of the agricultural extension service and their responses were 47(43.5%) confessed divisional level, 29(26.9%) pointed out location level, 16(14.8%) cited district level while 11(10.2%) of respondents signified sub-location level and only 4(3.7%) showed village level as shown in the figure 4.8

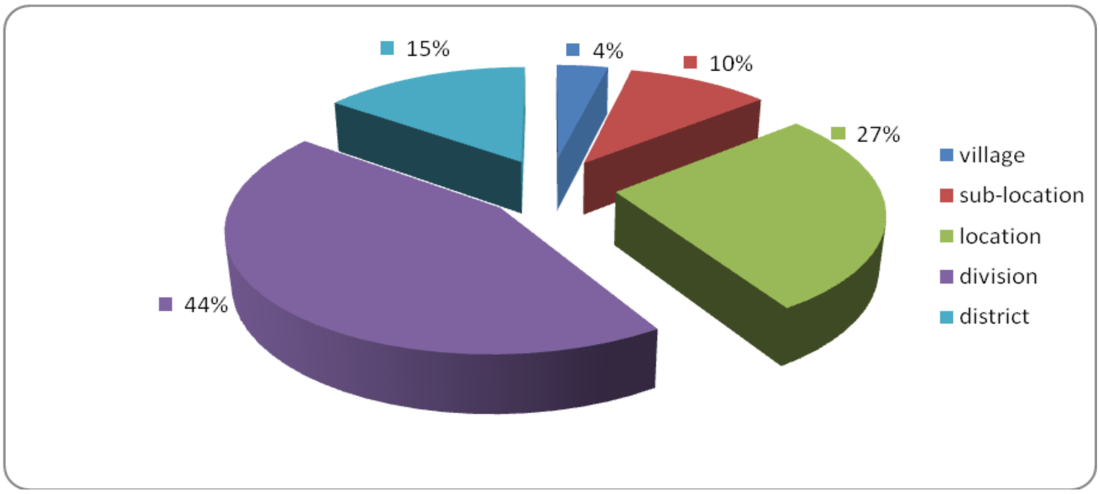


Figure 4.8: Level of accessibility to agricultural extension service

4.5.4.4 Suggestions for proper management of soil erosion and improvement of maize production

The researcher asked the respondents to suggest the best ways of managing and improving maize production in their Division and their views were as shown below:

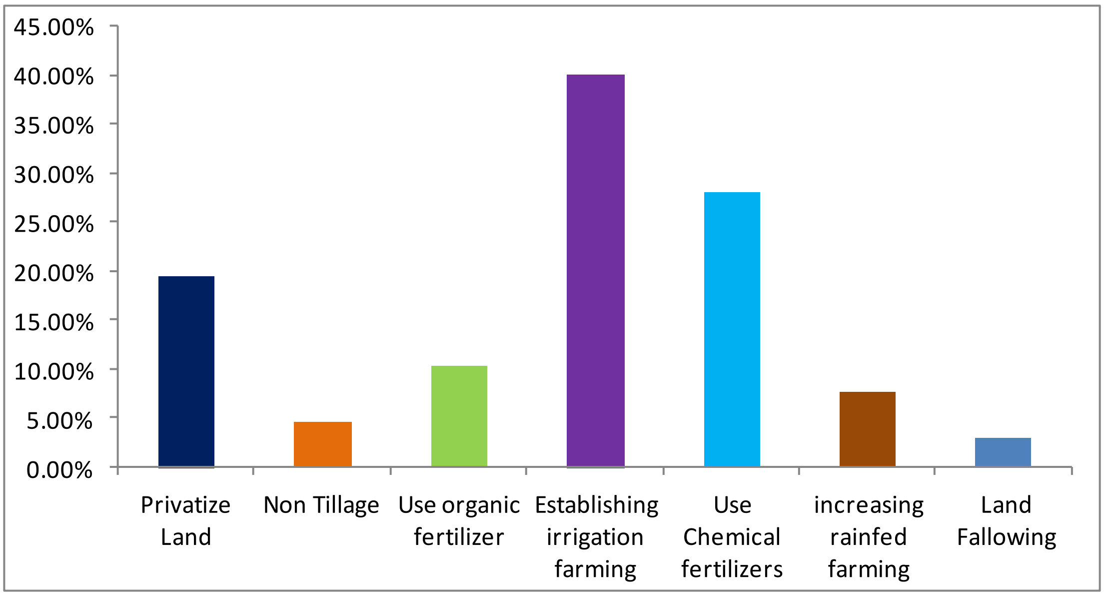


Figure 4.9 Farmers' views on solutions for improved maize yield.

Most respondents who were 37(40%) indicated establishing irrigation farming as the best way, 26(28.1%) said the use of inorganic or chemical fertilizers was the solution whereas 18(19.4%) respondents acknowledged privatizing land while 11(11.1%) stated that organic fertilizer or manure could help. Still, a significant number of respondents who were 8(8.6 %) mentioned increasing rain fed farming as 5(5.4%) avowed non tillage and 3(3.2%) respondents pointed out land fallowing as the best remedy. This implies that farmers viewed the increase of maize production and sustainability could be done through adaptation of irrigation farming and fertilizers.

4.5.4.5 Factors Limiting Soil Conservation

The study sought to find out the constraints encountered by farmers in soil conservation as they carry out maize cultivation and the extent of limitation. Majority of the respondents who were 47.8% indicated land ownership as much limiting while 23.5% indicated moderate limiting and 12.7% felt it was less limiting. Another 13.9% of respondents approved land ownership as limiting while 2.1 % avowed it as not limiting. Labour was the second feature recognized by 46.6% of respondents as much limiting, 27.4% accredited moderate limiting while 8.9% admitted less limiting. Whereas 11.5% agreed that labour was limiting, 2.6% of respondents declared it was not limiting. Time and interest was specified by 40.9% of respondents as much limiting, 21.6% accepted it as moderate limiting and 13.0% approved to be less limiting. Other 17.8% respondents affirmed that it was limiting and 1.7% said it was not limiting. In the fourth position was technology indicated by 34.8% of the respondents as much limiting, 26.7% said it was moderately limiting, 18.5% stated less limiting 16.4% affirmed that it was limiting and 9.7% were of the opinion that it was not limiting. The lack of building material was also presented and 28.4% avowed much limiting, 30.6% declared it was moderately limiting, 22.1% indicated less limiting, while 10.4% said it was limiting and 9.5 were of the opinion that it was not limiting.

Table 4.15 Limiting factors to soil conservation measures.

Limiting factor	Much limiting	Moderate limiting	Less limiting	Limiting	Not limiting
Time/interest	40.9	21.6	13.0	17.8	1.7
Technology	34.8	26.7	18.5	16.4	3.6
Labour	46.6	27.4	8.9	11.5	2.6
Lack of building material	28.4	39.6	22.1	10.4	0.5
Lack of tools /equipment	23.5	45.1	15.6	13.9	1.9
Knowledge	29.3	38.3	16.7	13.8	3.2
Land ownership	47.8	23.5	12.7	13.9	2.1

The fifth factor was knowledge selected by 26.3% of respondents as much limiting, 38.3% indicated moderate limiting, 16.7% confirmed less limiting, whereas 13.8% chose limiting and 3.2% said it was not limiting. Finally, 23.5% of respondents mentioned lack of tools and/or equipment as much limiting, 45.1 said it moderate limiting, 15.6% declared less limiting while 13.9% avowed limiting and 1.9% felt it was not limiting. From the finding it implies that most farmers were still engaging on old method of farming and little was done on soil conservation due to lack of labour which requires youth and energetic people and finance to hire it.

4.5.4.6 Responsibility for Prevention of Soil Erosion

The study also asked respondents to say whom they thought was responsible for prevention of soil erosion in their lands and neighborhoods and most respondents who were 47(43.5%) mentioned individual farmer, 34(31.5%) acknowledged the community, 15(13.9%) said county government while 8(7.4%) stated central government and only 4(3.7%) said it was the responsibility of NGOs and CBOs.

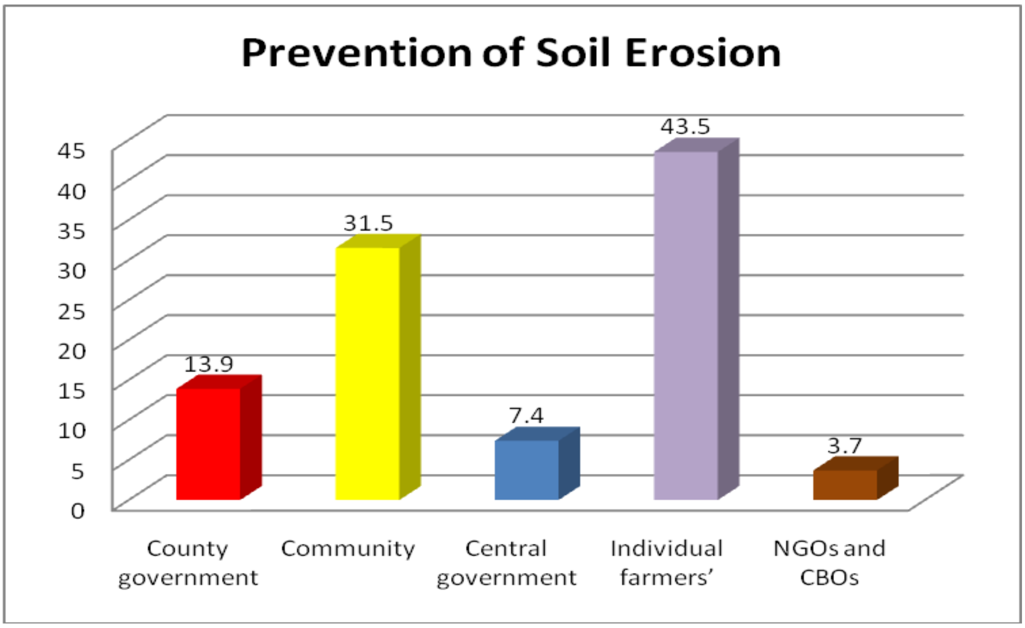


Figure 4.10 Farmers' views on soil conservation responsibility

From the findings it implied that individual farmers should be responsible for soil conservation as the owners and beneficiaries of cultivation activities in their lands.

4.6 Discussion of Findings

The researcher consequently discussed the research findings and observed phenomena in the field on farmer perceived impact of soil erosion on maize production in Soy Divison, Elgeyo Marakwet County.

4.6.1 Farmers' knowledge of soil erosion

4.6.1.2 The concept of 'soil erosion'

The farmers' understanding of soil erosion was inquired and was apparent that soil erosion phenomenon was not a new concept to the farmers in the area of study. Most of them gave agreeable explanation of the term ‘soil erosion’, for instance one explanation was given as the removal of top soil by agents such as running water, animals, wind and/or man. This concurs with the sentiments of Diamond, (1990) who said that soil erosion is a naturally occurring process of loosening (detaching) and transporting soil particles and added that water is the most common agent of land degradation especially through soil erosion that takes place all the time in many parts of the world as a normal geological process but becomes a problem when it goes above this geological level. WhileTiffen, *et al*., (1994) in his research in Makueni district affirmed that soil erosion by water is the major form of land degradation.

This was contrary to what Mokma, Sietz, Soil (2002) found out in Honduras that many farmers talk about ‘rocks growing out of the hillside’, as they could not see erosion occurring, the explanation of rocks growing is a logical explanation for rocks becoming exposed. Another contradiction was by Escribano, (2006) in Cochabamba, Bolivia, who maintained “Land users were not at all aware of the soil erosion problem".

On the occurrence of soil erosion majority of the farmers were aware of the episode as affirmed by 70.4% of the respondents. It is possible that most of those confirming the occurrence of soil degradation especially soil erosion were farmers parse, particularly those who do farming with the aim of selling the surplus especially those situated along the Kerio Valley and those living in the higher parts of the escarpment. While 21.3% of respondents refuted, 8.3% did not know anything about soil erosion which could be those situated on the marginal areas of the hanging valley that relied entirely on subsistence type of farming. The findings indicated that the majority of respondents were aware and knowledgeable of the occurrence of soil erosion effects on maize yield in their areas of residence.

Majority of the respondents also pointed out rill erosion as very severe and gully erosion as being severe supported by 36.1% and 45.4% of respondents respectively. This illustrated the actual status of soil erosion in the area of study despite the farmers' knowledge and awareness of the occurrence of the event in their lands and neighborhoods. Majority of the respondents, 47.9% stated that root exposure was very severe while 44.9% acknowledged rill erosion as being very severe whereas stoniness as a sign of erosion was supported by 35.2% respondents as being very severe.

This demonstrates that soil erosion was a reality in Soy Division. Rampant rill and gully erosion was witnessed in the lower parts of the valley especially on the lands bordering the Kerio River while splash and sheet wash erosion associated with the upper parts of the valley especially the areas bordering the hanging escarpment where the lands were flat and others gently sloping. This consents with the findings of Mutunga and Mwarasomba , (1998) who, in their studies in ASAL areas of Kenya, established that farmers were aware that soil erosion was damaging their land with 98% of farmers experiencing soil erosion, a phenomenon they related to the widespread on-site erosion indicators; rills, followed by root exposures, sheet wash (runoff flow paths) and the change of soil colour to red (red soils) whose formation they attributed to factors including high rainfall, runoff from upslope fields, steep slopes and poorly designed or ineffective SWC measures, which they find themselves incapable of changing due to topographic situations of the lands.

4.6.2 Causes of soil erosion

The study explored the causes of soil erosion and majority of the respondents who were 41; 44.28% attributed it to poor cultivation practices mainly (up-down ploughing, planting and weeding, slash and burn method, poor terracing shifting cultivation, spaced trash lining), while 25; 27% acknowledged slope gradient and length whereas 18; 19.44% and 13; 14.04% respondents avowed rainfall intensity and run off and cultivation of marginal areas respectively. These were ideas similar to Nandwa et al, (2000) who asserted that as human population grew more natural forests were cleared for agricultural activities which increases soil erosion. It also consents with Tiffen, *et al*., (1994; Baldwin 2005) who averred that soil erosion in the cultivated fields is commonly associated with lack of ground cover for the first month after planting as shown in plate 4.1 a) and b): which show bare ground and non existence of a conservation measure in Turesia sub-location, Soy location, which was justified in the study finding as a cause of soil erosion in the study area:

Plate 4.1: (a): Bare ground on a farm in Turesia sub-location Soy location

Plate 4.1(b): Non existence of a conservation measure in Turesia Soy location.

Trimble (1994) averred that cultivation practices leave the soil barren and fully exposed to rain and wind energy. Erosion rates on sloping lands are exceedingly high. Erosion rates are high especially on marginal and steep lands that are being converted from forests to agricultural use to replace the already eroded, unproductive cropland as depicted in plate 4.2.

Plate 4.2: Maize cultivation in steep areas in Chepsirei sub-location, Chemoibon location

Omaffra Staff: Wall (2005) also elucidated that the rate and magnitude of soil erosion by water was controlled by factors such as rainfall intensity and runoff, and soil erodibility, slope gradient and length; naturally the steeper the slope of a field, the greater the amount of soil loss from erosion by water.

However, it differs with the ideas in Cochabamba, Bolivia, that attributed erosion to the increased frequency and intensity of torrential downpours, referred to as "crazy rains" (loco paras).'’(Swinton, Lupi, Robertson, Hamilton, 2007). This is proven by the escarpment areas comprised of steep and very steep slopes which were associated with splash and rill types of erosion especially parts of Turesia, Chang;ach and Epke sub-locations which are situated in the hanging escarpment as shown in plate 4.4 a) and b) which shows spaced terraces (nappier and trash lines), and some farms without conservation measures in Tumeiyo sub-location, Chemoibon location. Rockstro¨m et al., (1999), added that soil erosion by water increases as the slope length increases due to the greater accumulation of runoff.

Plate 4.3 a): Spaced terraces (nappier and trash lines), in Tumeiyo sub-location, Chemoibon location.

Plate 4.3 b): Steep areas with maize farms, some without conservation measures in Epke sub-location.

The farmers' sentiments are also in agreement with findings by Steiner (1998) on farmers in Rwanda who associated soil suitability with slope position. Steeper slopes generally had shallower soils whereas on plateaus and foot slopes fine-textured soils dominated, implying soils of high fertility were easily eroded when residents farm steep and marginal areas such as shown below:

Plate 4.4: Farms without conservation measures in Tumeiyo sub-location.

Farmers in the lower valley believe that soil erosion does not occur in their lands as they are situated in the flat region thus do not carry out soil and water conservation methods and practices as shown below :

Plate 4.5 a): A farm without conservation structures in Kabito sub-location

Plate 4.5 b): Land lacking conservation structures in Chebinyiny Sub-Locaion, Chepsigot location, Kerio Valley

The findings from the study showed that deforestation and poor methods of cultivation were factors of soil erosion. This is in support of plate 4.5 that shows land lacking conservation structures in Chebinyiny Sub-Locaion in Chepsigot location, Kerio Valley. A related study by Woldeamlak (2006) blamed the gradient of most farmlands in the Bokole watershed as being steep, thus increases erosion. Also, rampant erosion on the grazing lands which was attributed to increased livestock numbers against diminishing land size due to land fragmentation. The tufted and patchy perennial grasses were grazed down, delayed germination or growth of grasses and herbs thus exposing the intermitted bare soil to erosion enhanced by the nature of the rainfall regime which is predominantly rainstorms which are relatively short and intense have great impact on soil erosion due to high surface runoff compared to low infiltration rate.

4.6.3 Impact of Soil Erosion on Maize Production

The study sought to asses the impact soil erosion on maize production.

4.6.3.1 Trend of Maize Production

The perceptions of farmers concerning crop yield due to the occurrence of soil erosion had majority of the respondents, 73.1% confirming that maize production was decreasing while 22.2% said it was maintaining which is in line with Wall, (2003) who averred that food production in Sub-Saharan Africa (SSA) has remained stagnant and in many instances even declined. Among the factors fuelling the continent's low agricultural outputs include continuing environmental degradation; particularly soil erosion, minimal use of inputs (fertilizer, improved seeds and irrigation) and adverse policies undermining agriculture.

4.6.3.2 Reasons for the Trend of Maize Production

The findings showed 38 % of respondents blamed inadequate rainfall, 23.2% declared soil erosion as the cause and 14.8% attributed it to diseases whereas 12.1% of respondents avowed that the non usage of chemical fertilizers was the reason. This concurs with the opinion of Hellin and Haigh, (2002) who affirmed that in countries such as Honduras, the amount and distribution of rainfall has a much more profound impact on yield than the amount of soil eroded though yields are actually determined by a complex interaction of factors including soil quality, crop and land management systems, and climate.

Plate 4.6: Unutilized goats' and sheep's manure

On-site and Off-site effects of soil erosion

The core aim of this study was to examine the perceptions of farmers concerning the effects of soil erosion on maize yield. The six factors investigated showed that majority of the respondents who were 49.3% strongly agreed with the idea that the removal of valuable top soil leads to reduced maize yield and 19.8% agreed which consents with farmers in Central Highlands of Kenya who knew that the rate of soil loss and level of soil fertility were related, which consequently determined crop-yield potential at any landscape position.

They also perceived that steep and very steep slopes were landscape segments with a high risk of soil erosion and low levels of soil fertility resulting in low crop yields. Morgan, (1996; opined that yield reduction was attributed to decreased availability of water-holding capacity on severely eroded fields. While it is probable that the 14.1% of respondents, who were not sure, might not be farmers perse, the 13.2% who disagreed and the 4.8% of respondents who strongly disagreed were possibly those who carried out their cultivation along River Kerio not aware of the occurrence of soil.

The idea that the loss of organic matter/residues and applied manure off field leads to reduced maize yield had most respondents who were 31.2% strongly agreeing and 38.1% agreeing. This concurs with Clarke, (1992) who averred that soils contain microorganisms, which decompose plant and animal residues, and microbes such as Rhizobium bacteria, which help certain plants to fix nitrogen from the air and hence raise crop yield. He added that organic components consist of decomposed plant and animal residues (organic matter); together clay and organic matter have the ability of adsorbing cations/nutrients, playing a crucial role to plant nutrition and thus influence crop yield. Though a significant number of respondents, 9.7% were not sure while 13.9% disagreed and 7.1% strongly disagreed this could be attributed to lack of knowledge. In addition, Tiffen, *et al*., (1994) claimed that farms which are experiencing nutrient deficiency subsequently contribute to food shortages. Pimentel and others (1995a) also added that erosion adversely affects crop productivity by reducing water availability, the water holding capacity of the soil, nutrient levels, soil organic matter, and soil depth.

In the third place was disturbance or destruction of maize seeds and plants leads to reduced maize yield which had 29.6% of respondents strongly agreeing and 31.7% agreeing. This concurs with Shelton (2005) who stated that a corresponding increase in the amount of runoff water can contribute to greater rill erosion problems. The lower nutrient levels often associated with sub-soils contribute to lower crop yields and generally poorer crop cover, which in turn provides less crop protection from the soil and other materials carried by water runoff.

Fourthly, was stunted growth of maize seeds and plants due to lack of adequate nutrition and fertilizer loss leads to reduced maize yield that had 25.9% strongly agreeing and 35.6% agreeing which consent with FAO (2000) which stated that lack of nitrogen leads to stunted growth of crops followed by pre-mature yields while low potassium leads to poor development of leaves, stem and branches of the plant hence low yields. Finally, slowed or delayed maize seed emergence (germination), leads to reduced maize yield had 34.3% of respondents agreeing and 24.7% strongly agreeing which was in agreement with http://www.sardc.net, (2005) which asserted that loss of soil (and its nutrients) from farmland may be reflected in permanent reduced crop production and damage to the environment and that nutrient losses are often not directly accounted for and are a hidden cost of soil erosion. Soil erosion is associated with about 85 percent of the world’s land degradation, which causes a 17 percent reduction in crop productivity.

4.6.4 Soil Erosion Mitigation measures

4.6.4.1 Soil Conservation Methods

The commonly mentioned soil erosion mitigation methods being used by farmers in the study area were terracing particularly channel terracing indicated by 34.3% of respondents while 24% affirmed planting strips of grass (nappier) while trash lining and soil bunds were declared by 16.7% and10.2% of respondents respectively, whereas, 7.4% of respondents stated bush fallowing. This was as shown in plate Plate 4.5: showing Grass strips (Nappier) and Stone bunds and grass strips were used as measures of soil conservation methods.

Plate 4.7: Grass strips (Nappier) & Stone bunds

This was in agreement with (Lambert, Sullivan, Claassen, Foreman, 2007)who emphasized the need to implement known soil conservation techniques, including, terracing and grass strips, biomass mulches, and ridge till, and combinations of these. All of these techniques basically require keeping the land protected from rainfall effects by some form of vegetative cover. It also consents with Wenner's simple terracing procedures, concentrated on building bench terraces to change the degree of slope, retarded runoff and retained eroded soil, moisture and nutrients. Bench terraces were built from grass strips which acted as washstops; unploughed strips, planted grass or trash lines laid along the contour (Abera, 2003).

4.6.4.2 Soil Conservation Practices

The findings indicated that intercropping or mixed cropping were approved by 38.9% of respondents followed by cover crops designated by 21.3% of respondents, and contour ploughing and planting stated by 13.0% respondents. This can be further supported by plate Plate 4.8 Mixed/Intercropping and Plate 4.6 Cover cropping, crop rotation and tree planting as a way of conserving soils.

This was in line with Wenner' work in Machakos District where he focused attention on improved crop management combined with simple terracing practice. He emphasized the importance of ground crop cover to reduce rainfall impact in rainy season and maintenance of a continuous layer of crop residues on off season to reduce surface run-off and increase the rate of infiltration and water retention in the ground as depicted below:

Plate 4.8 a): Mixed/Intercropping Emsea sub-location, Kibargoi location

Plate 4.8 b) Beans cover cropping and tree planting on the Escarpment in Turesia

Plate 4.8 c) Cover cropping and crop rotation in Turesia sub-location, Soy location.

He also gave special attention to contour ploughing and planting, crop rotations and no till to maintain soil structure. Lal, R., (1999) pioneered no-till/zero tillage agriculture, in Nigeria showing losses on tilled land could be as high as one ton per hectare per month on ten percent slopes, even under crops. Untilled production reduced erosion by 98 percent and significantly reduced water runoff.

In general the multipurpose role and benefits from grass strips could explain the high adoption rates serve as a main source of fodder for livestock as well as a good filtering hedge against water runoff. It is also used to stabilize risers of fanya juu terraces. Duveskog, (2003) stated that farmers tend to go for short-term return systems (mulching and grass strips) rather than labour-intensive conservation systems. Awareness and adoption of bench terraces and Fanya Juu measures can be linked to the colonial legacy whereby these measures were adopted by coercion (Kiara et al., 1999).

4.6.4.3 Accessibility to agricultural extension service on agricultural activities

(i) Accessibility to agricultural extension service

There was indication that farmers agricultural extension service was available though as confirmed by majority, 78.7% of the respondents while 23; 21.3% disproved. This concurs with Carl Wenner in association with the Kenyan Ministry of Agriculture developed a series of extension exercises to reduce erosion. This is in agreement with Malawi's government which uses a centralized, top-down; "block-extension-system" approach to extension needs which is a modification of the train and visit approach introduced in the 1980s (Tenge, et al., 2004).

(ii) Level and frequency of accessibility of agricultural extension service

The frequency of accessibility of agricultural extension service had 43.5% of respondents confessing divisional level while 26.9% of respondents pointed out locational level and 14.8% cited district level. The frequency of accessibility majority who were 34.3% of respondents specified accessibility on yearly basis while 23.1% declared availability after six months and 17.6% of respondents admitted accessing it in three months period. As agricultural activities are found in people's homesteads farmers require agricultural extension service at village and sub-locational level to be always available. This will be similar to Malawi situation where every extension planning area has one land husbandry officer who is responsible for the soil and water conservation and agroforestry activities (Ministry of Agriculture, 1993/1994).

4.6.4.4 Suggestions for proper management of soil erosion and improvement of maize production

Suggestion for proper management the most respondents were 23.1% indicating establishing irrigation farming as the best way to manage soil erosion and improve maize yield which shares similar opinion with Ovuka, (1999) who averred that irrigation is essential for global food production if well managed to minimize erosion and maintain soil productivity. Other respondents, 19.4% said the use of inorganic or chemical fertilizers would improve maize yield whereas 13.9% respondents felt organic fertilizer or manure could help. This consents with Khaemba *et al*., (1999) who maintained that a combination of conservation structures (Fanya juu terrace; grass strips; trash lines) and types of forage grasses in Cheptuya, west Pokot, were preferred by farmers. The grasses were preferred in the order of Napier, Rhodes, panicum, makarikari, which were less labour intensive biological conservation structures with grasses/fodders that can be utilised as livestock feed. In southwest Kenya at Nyamonyo, maize stover trash lines and sweet potato strips were recommended for short-term control while makarikari and vetiver grass strips provided the best option for long-term control (Nzabi *et al*., 2000).

4.6.4.5 Factors limiting soil conservation

Constraints encountered by farmers in soil conservation had majority of the respondents who were 46.3% indicating land ownership as much limiting which is supported by Lapar and Pandey, (1999); who in their study found that farmers with land-tenure security other than title deeds, tended to adopt low labour-intensive SWC options. Farmers view conservation measures as an investment thus leased it and communal land was temporary ownership and farmers constructed few and spaced terraces and trash lining which is a contradiction because the more SWC measures a farmer had, the more effectively erosion was controlled. This leads to higher productivity and higher cash income and helps to solve the other constraints typically experienced by small-holder farmers (Tenge et al., 2000). Labour was the second feature recognized by 43.6% of respondents who affirmed much limiting, which consents with Kidanu, (2004) who avowed that some of the listed adoption constraints were the lack of labour and tillage tools. Time and interest was specified as moderate limiting which could be attributed to laziness and lack of recognition of the benefits of soil conservation methods and practices.

4.6.4.6 Responsibility for prevention of soil erosion

Responsibility for the prevention of soil erosion in their lands and neighborhoods and most of them, 43.5% mentioned individual farmer, 31.5% of respondents acknowledged the community while 13.9% said the county government, 7.4% of respondents stated central government Though the responsibility of soil conservation lies with the individual land owners, the community through elders can assist in maintaining the existing vegetation and planting more indigenous trees in marginal areas to avert further erosion and retain soil fertility. The county and national government can assist farmers by motivating them through provision of agricultural extension service, subsidized fertilizers and hybrid seeds, and marketing their maize produce. They can contribute to soil conservation by enacting laws on forest preservation and maintenance whereas NGOs and CBOs can work in liaison with the community to coordinate community self-help soil conservation and maintenance projects.

4.7 Analysis of information of the key informants

In addition to face to face interviews of local residents the study undertook in-depth discussions with officials from the ministries of agriculture, water, livestock and environment, NGOS, CBOs and chiefs. This section presents respondents' views the term 'soil erosion' and its characteristics, causes, the impacts of soil erosion on maize production and the soil conservation methods and practices applied in the area of study. It also gives suggestions for solutions of soil erosion and improvement of maize production. Most of the respondents in this category were employees in government, companies or casual workers in NGOs, CBOs and other social work programmes and therefore majority were aged between 45 and 54 years. Their education level was dominated by those who finished primary, followed by those who went through secondary education then college graduates and the least were university graduates.

Farmers' knowledge of soil erosion was inquired and the findings showed that majority of government officials believed that soil erosion is a problem in their respective areas of work. They explained soil erosion as the carrying away or the transportation of fertile top soil from farmlands down slope to valleys, rivers and eventually to lakes. They specified soil profile, heaps of transported material (such as soil, stones and trash; leaves and grass), rills, gullies and landslides as the main indicators of soil erosion. Other signs of soil erosion mentioned were exposure of tree and crop plant roots, bare ground and exposed stones. The result illustrated that respondents were knowledgeable of soil erosion and its indicators and were aware of its occurrence in their areas of jurisdiction.

They were asked the causes of soil erosion and most of the respondents mentioned the cultivation of marginal areas, the steepness of slopes and poor cultivation practices', (up-down ploughing, planting and weeding, rampant slash and burn method, poor terracing). They attributed it to major acceleration of erosion in most areas of the division especially the escarpment which experiences frequent mass wasting through rock falls, rockslides and occasional landslides. They also said that the consequence of poor cultivation practices presents a threat to soil fertility and crop production and that the ideal conditions for maize production include adequate rainfall, viable maize seeds, early planting and weeding and appropriate pest control. Also mentioned was slope length as a factor that contributes to accelerated erosion. They were of the view that the longer the slope the higher the speed and strength of the runoff as influenced human activities especially poor farming practices and deforestation which causes massive erosion leading to rill and gully erosion particularly in the hanging valley and along the Kerio River due to the accumulation of water runoff from the escarpment.

Other factors mentioned include, the cultivation of catchment areas and rivulets and overgrazing and overstocking. A majority of the interviewed CBOs and NGOs officials suggested that proper management of the soil can help maximize infiltration of surface run-off. They also blamed the clearing of bushes to expand cultivation mainly of maize as their staple food crop, for settlement and firewood. However, farmers' inactiveness and poverty were also mentioned as hindrances to soil and water conservation and consequent improvement of maize yield in the study area.

On the effects of soil erosion on maize yield the ministry officials, CBOs, NGOs and the chiefs cited leaching as the major on-site effect and a phenomenon that has a long term effect, especially on reduced maize yield. They also revealed that the removal of valuable top soil leads to the loss of organic matter/residues and applied manure off field resulting to reduced maize yield. This is through the loss of soil nutrients through high soil infiltration on the slopes in the escarpment and majorly in the valley. They also mentioned surface runoff on sloppy areas as disturbing maize seed germination and growth, as it carries large amounts of soils and trash during heavy down pour which causes destruction on maize seeds and plants both upstream and downstream in the division. They also mentioned off-site effects as including slowed or delayed seed crop emergence due to transported materials left on planted land down slope leads to reduced maize yield. Eroded soil carried destroys maize seeds down slope and buries small maize seedlings.

On conservation methods majority of the respondents stated that the main soil and conservation methods applied in the division were terracing especially channel terracing, soil bunds and planting of grass (nappier grass) in the lower valley, whereas trash lining, stone bunds and planting of grass were practised in the Escarpment. The major conservation practices they admitted being applied in the division included intercropping, contour ploughing and planting and crop rotation. Most of the informants stated that the main constraints to soil conservation and maize production were lack of labour, lack of finance, lack of knowledge and land tenure insecurity. Other interviewees were of the view that the main limitations were lack of skills or technology, lack of tools and equipment whereas small land size and lack of government support were also mentioned as limiting factors. In summary the interview found out that erosion is affected by numerous variables of which soil type, climate, vegetation and drainage basin characteristics like steepness of slope, drainage density and relief are the most important in relation to soil erosion and maize production.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study investigated the farmers' perceptions of the impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County, Kenya. This chapter summarized the findings of the study, drew conclusions and made recommendations and suggestions for further research.

5.2 Summary of Findings

5.2.1 Farmers' knowledge of soil erosion

It was apparent that farmers' were knowledgeable about soil erosion phenomenon and were aware of its occurrence in their farms and neighborhoods. Most of them gave agreable explanation of the term 'soil erosion', for instance one explanation was given as the removal of top soil by agents such as running water, animals, wind and/or man. On the occurrence of soil erosion majority (70.4%) of the farmers confirmed their awareness of the episode.

The findings also showed that rill and sheet erosion were the main types of soil erosion experienced by farmers in the study area as avowed by 38.1% and 28.7% of the respondents respectively. This illustrated the actual status of soil erosion in the area of study despite the farmers' knowledge and awareness of the occurrence of the event in their lands and neighborhoods. It was also evident that the signs or indicators of soil erosion were root exposure and rill erosion as affirmed by 47.9% and 34.1% of respondents respectively. This therefore demonstrates that soil erosion was a reality in Soy Division.

5.2.2 Factors Influencing Soil Erosion in Soy Division

The study findings revealed that the main cause of soil erosion were poor cultivation methods and slope gradient and length of the general area as supported by 36.1% and 23.1% of respondents respectively. Other mentioned factors influencing soil erosion were rainfall intensity and runoff and cultivation of marginal areas.

5.2.3 Farmers Perceived Impacts of Soil Erosion on Maize Production

Farmers perceived maize production as decreasing due to the occurrence of soil erosion as confirmed by 73.1% of the respondents which is in line with Wall, G. (2003) who averred that food production in Sub-Saharan Africa (SSA) has remained stagnant and in many instances even declined due to factors including continuing environmental degradation; particularly soil erosion, minimal use of inputs (fertilizer, improved seeds and irrigation) and adverse policies undermining agriculture.

The reasons given for the trend of maize production were inadequate rainfall and soil erosion as pointed out by 38.0% and 23.2% of farmers respectively. Diseases and non usage of chemical fertilizers were also mentioned. The study further indicated that farmers believed that the removal of top soil through soil erosion contributes to decline in maize production in the region as acknowledged by 49.3%of the respondents. They also believed that loss of organic matter/residues and applied manure off field leads to reduced maize yield as stated strongly by 41.2% of the respondents. Moreover 29.6% of respondents strongly agreed that the disturbance or destruction of maize seeds and plants leads to reduced maize yield. The lower nutrient levels often associated with sub-soils contribute to lower crop yields and generally poorer crop cover, which in turn provides less crop protection from the soil and other materials carried by water runoff. Nonetheless 35.6% agreed that stunted growth of maize seeds and plants due to lack of adequate nutrition and fertilizer loss leads to reduced maize yield. Finally, 34.3% of respondents agreed that slowed or delayed maize seed emergence (germination), leads to reduced maize yield.

5.2.4 Mitigation measures on Soil Erosion

The research revealed that the mitigation methods currently applied by farmers in an effort to curb erosion in the area of study were channel terracing as affirmed by 34.3% of respondents, planting strips of grass was avowed by (19.4%) of respondents and others were trash lining and soil bunds. The findings further showed that 38.9% of the respondents indicated that they also use intercropping or mixed cropping to prevent soil erosion others indicated the use of cover crops, contour ploughing and tree planting. It was also noted that farmers accessed agricultural extension service as affirmed by 78.7% of respondents. These services were available at divisional level and locational level. As agricultural activities are found in people's homesteads hence farmers require agricultural extension service at village and sub-location level to be available always.

The findings indicated that farmers considered establishing irrigation farming as the best way to manage soil erosion and improve maize yield as avowed by 43.1% respondents. Other practices stated include the use of inorganic or chemical fertilizers and organic fertilizer or animal manure.

5.3. Conclusion

The study concluded that farmers in Soy Division are knowledgeable and aware about soil erosion as indicated by their ability to explain its meaning and acknowledge of its occurrence. However, their lack of concentration on proper management of soil erosion and water runoff was due to lack funds to hire labour and purchase adequate farm inputs in time. They indicated that rill and gully erosion were rampant in their farms. It was also realised that the common signs or indicators of soil erosion were root exposure, rills and stoniness.

The main factors that influence soil erosion were poor cultivation practices and slope gradient and length. On moderate slopes, uphill and downhill planting is estimated to reduce erosion by approximately 50% less than on steep slopes, where the hazard of rill erosion is increased. Row spacing, when used with other conservation tillage practices, is effective in reducing soil erosion on sloping areas.

The study also concluded that farmers believed that the occurrence of soil erosion resulted to reduction in maize yield as construed by factors such as the removal of top soil by running water that lead to loss of organic matter/residues, the disturbance or destruction of maize seeds and plants. Soil erosion also result to the loss of nutrients and fertilizer which in the long run has led to stunted growth of maize seeds and plants, slowed germination and hence reduced maize yield.

Farmers in most areas of Soy Division use terracing particularly channel terracing, planting grass, trash lining and intercropped maize and beans as cover crops. However farmers considered establishing irrigation farming as the best way to perfectly manage soil erosion and improve maize yield. It was also noted that famers accessed agricultural extension service at divisional and location level that were mainly available at intervals of six months in a year, though it was necessary to be available always.

5.4 Recommendations.

Based on the above findings and conclusions, it is recommended that;

i. Farmers need to adopt conservation methods and practices that offer multipurpose roles and benefits such as grass strips as a source of fodder for livestock as well as a good filtering hedge against water runoff.
ii. Farmers also could major in long term return soil and water conservation systems such as planting trees especially on the marginal escarpment areas in at least 20% of their land and construction of terraces.
iii. The farmers could also be motivated to adopt soil and water conservation measures and improve maize production through the provision of subsidized or free fertilizers and tree seedlings.
iv. Land tenure system also ought to be put under private ownership to enhance proper land use and sustainability.

5.5 Suggestions for Further Research.

The study suggested that the following areas be further researched on:

i. The role of gender in the management of soil erosion and improvement of maize yield.
ii. The role of government in soil and water conservation and improvement of maize production as food crop and a cash crop.
iii. The challenges faced in implementing land use policies.

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APPENDIX I: QUESTIONNAIRE FOR LOCAL RESIDENTS/FARMERS

Questionnaire No………..

Farmers' perceptions of the impact of soil erosion on maize production in Soy Division, Elgeiyo-Marakwet County.

I am Michael Kandie Kangogo, a postgraduate student at Moi University Eldoret, carrying out a research on the above topic. The information provided will be used to examine farmers' perceived impacts of soil erosion on maize production in this area. It will also be treated with utmost confidentiality and used only for the purpose of developing soil erosion management strategies that will help in improving maize production in the area of study.

Your cooperation is highly appreciated.

SECTION A: IDENTIFICATION OF RESPONDENTS

1. Location ……………… Sub-location ……………. Village …………….

2. Distance from major urban centre …………………….

SECTION B: DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

1. Gender: Male [ ] Female [ ]
2. Age : 15 – 25 [ ] 36 – 45 [ ] 56 – 65 [ ]
   26 – 35 [ ] 46 – 55 [ ] 66 and Above [ ]

3. Level of formal Education

None [ ] Primary education [ ] Secondary [ ]

College [ ] University [ ]

4. Family Size (No of family members) 1-5 [ ] 6-10 [ ] 11-15 [ ] 16-20 [ ] 21 and above [ ]

5. Length of stay in the study area in years:

Below 15 [ ] 16-30 [ ] 31-45 [ ] 46-60 [ ] 60 and above [ ]

6. Livelihood/Occupation (tick as appropriate)

Agriculture-Crop/Arable Farming	Pastoralism	Business	Employment	Others

<u>SECTION C: LAND TENURE AND LAND USE</u>

7. Land tenure system

Leasehold	Communal	Private/Individual	Others

8. (i) Types of crops grown: Rank appropriately and use their numbers to indicate the purpose; Crop Choice Purpose

Millet [ ] [ ]

Sorghum [ ] [ ]

Coffee [ ] [ ]

Maize [ ] [ ]

Beans [ ] [ ]

Groundnuts [ ] [ ]

Bananas [ ] [ ]

Fruits [ ] [ ]

(ii) Types of animals reared: method;

Rank appropriately and use their numbers to indicate the method and purpose:

AnimalMethod / type of rearingImportance / purpose

Dairy cows [ ] [ ]

Beef [ ] [ ]

Zebu [ ] [ ]

Cross-breeds [ ] [ ]

Oxen [ ] [ ]

Goats [ ] [ ]

Sheep [ ] [ ]

Donkeys [ ] [ ]

Others…………………………………………………………

SECTION D: KNOWLEDGE OF SOIL EROSION

1. (i) Does soil erosion occur in your land and neighbourhoods? (Tick as appropriate)

Yes [ ] No [ ] Don't know [ ]

(ii) If yes, indicate the type of soil Erosion and the extent of severity**.**

Erosion Type	Tick as appropriate	Very severe (1)	Severe (2)	Moderate (3)	Mild /Slight (4)	Not at all (5)
Splash						
Sheet						
Rill						
Gully						

(iii) What are the indicators and extent of soil erosion severity in your land and the neighborhoods?

Indicators/Signs	Tick as appropriate	Very severe	Severe	Moderate	Slight/ mild	Not at all
Root exposure						
Splash particles on objects/ leaves						
Sheet wash						
Red soil						
Rill						
Stoniness						
Others						

SECTION E: CAUSES OF SOIL EROSION

2. Soil erosion is a big problem, what do you see as the main factors influencing it in your area?

Factor	Rank in order the first 1-6 in order of significance
Overgrazing	
Overstocking	
Cutting trees (Deforestation)	
Drought	
Rainfall intensity and run-off	
Population growth	
Soil erodability	
Slope gradient and length	
cultivation of river banks	
cultivation of marginal areas	
cultivation of catchment areas	
Poor cultivation practices	

SECTION F: IMPACT OF SOIL EROSION ON MAIZE PRODUCTION

3. (i) What is the trend of maize production for the last five years?

1 Decreasing. 2 Maintaining. 3 Increasing.

(Use the numbers to indicate the trend of production**)**

Year	Size of land under maize production	Yield of maize in 90 kg bags	Trend of production
2009			
2010			
2011			
2012			
2013			

(ii) Reasons for the trend of production

Reason	Rank the first 1-6 in order of significance
1.Non usage of chemical fertilizers	
2.Usage of chemical fertilizers	
3.Non usage of manure	
4.Usage of manure	
5.Adequate Rainfall	
6.Inadequate Rainfall	
7.Drought	
8. Soil Erosion	
9. Nutrient depletion/leaching	
10. Usage of cow/sheep/goat dung	
11. Non usage of cow/goat/sheep dung	
12. Non tillage	
13. Poor tillage practices	
14.Weed and pest control	
15. Non-weed and pest control	

(iii) What are your views on the effects of soil erosion on maize production?

Use the likert scale to rate the given statements: SA= strongly Agree; A= Agree; NS= Not sure; D =Disagree; SD = Strongly Disagree.

(a) On-site effects

Effects	SA	A	NS	D	SD
Removal of valuable top soil that leads to reduced maize yield					
Slowed/ delayed seed crop emergence that leads to reduced maize yield					
Stunted growth on crop/seed due to lack of adequate nutrition and fertilizer loss that leads to maize yield.					
Disturbance of crop seeds and plants and destruction that leads to reduced maize yield.					
Loss of organic matters or residues and applied manure off the field leads to reduced maize yield.					
Others					

(b) Off-site effects

Effects	SA	A	NS	D	SD
Eroded soil is deposited down slope, destroy maize seeds and plants that leads to reduced maize yields					
Eroded and deposited soil inhibits or delays seed emergence that leads to decreased maize yield					
Eroded and deposited soil, bury small seedlings that leads to decreased maize yield					

Others……………………………………………………………………………

SECTION G: SOIL EROSION MITIGATION MEASURES

4. Do you practice any of the following methods and practices in your cultivation?

(i) Soil conservation methods

Conservation Methods	Rank the main 1-6 in order of significance
Planting trees	
Planting grass	
Controlled grazing	
Livestock rotation	
Terrace farming -bench -channel	
Water conservation structures	
Gully control (Gabions)	
Trash lines	
Stone bunds	
Soil bunds	
Bush fallowing	
Grass strips	

Others………………………………………………………………………………

(ii) Soil conservation and cultivation practices: Rank the main 1-6 in order of significance the ones used in your land and neighbourhoods.

1. Cover crops [ ]
2. Crop rotation [ ]
3. Intercropping [ ]
4. Contour ploughing [ ]
5. Non tillage [ ]
6. Minimum tillage [ ]
7. Use of herbicides [ ]
8. Use of organic fertilizer [ ]
9. Use of animal manure [ ]
10. Listing / ridging [ ]
11. Strip cropping [ ]

SECTION H: SUGGESTIONS FOR SOIL EROSION MANAGEMENT AND IMPROVED MAIZE PRODUCTION

5. (i) Which of the following should be done to prevent further soil erosion and improve maize production in your land and the neighborhoods?

Action	Rank the main 1-6 in order of significance
Privatize land	
Increase rain fed farming	
Establish irrigation farming	
Control tree cutting	
Reduce livestock	
Control grazing	
Build terracing	
Create alternative income Opportunities	
Land fallowing	

(ii) Are the following factors limiting you to do more and better soil control and conservation?

Limitation	Tick as appropriate	Much limitation	Moderate limiting	Little limiting	Limiting	Not limitation
Labour						
Technology						
Knowledge						
Building material						
Lack of tools / equipment						
Interest/Time						
Land ownership						

Others…………………………………………………………………………………

(iii) Who has the main responsibility for preventing further soil erosion?

Responsibility	Rank the main 1-6 in order of significance
1. Central government	
2. County government	
3. Community	
4. Individual farmer	
5. NGOs & CBOs	
Others	

10. (i) Are you accessible to agricultural extension service on agricultural activities?
Yes [ ] No [ ]

(ii)If yes, above: (a) How often? Weekly [ ] Monthly [ ] Three months [ ] Six months [ ] Yearly [ ] Two years [ ] Five years [ ]

(iii) At what level? Village [ ] Sub-location [ ] Location [ ] District [ ] County [ ]

THANK YOU FOR YOUR COOPERATION

APPENDIX II: INTERVIEW SCHEDULE

For Key Informants: Officials from Ministries of Agriculture, Water, Livestock and Environment, NGOs, CBOs and Chiefs.

1. Gender

Male [ ] Female [ ]

2. Age :

15 – 24 [ ] 25 – 34 [ ]

35 – 44 [ ] 45 – 54 [ ]

55 – 64 [ ] 65 and Above [ ]

3.Location……………………

Ministry/Department………………………………………

4. Level of Education

None [ ] Primary [ ] Secondary [ ]

College [ ] University [ ]

5. (i) Do you see soil erosion as a serious problem in your location or area of work?...

(ii) What are the indicators/signs of Soil Erosion in your location or area of work?

....

6. (i) What are the natural factors that influence accelerated soil erosion in your location or area of work?..

(ii) What are the human factors that influence soil erosion in your location or area of work? ……………………………………………………………………………..

7 (i) What are the effects of soil erosion on maize production in Soy Division, Keiyo-Marakwet County?...

8. (i) What is the trend of maize production in your area for the last five years?

1. Decreasing ( ) 2. Maintaining ( ) 3. Increasing ( )

(ii) What could be the reasons for the trend of production indicated above?

………………………………………………………………………………………

(iii) What are your views on the effects of soil erosion on maize production?

(a)On-site effects/up slope…………………………………………………..

(b) Off-site effects/down slope………………………………………………

9. (i) Which soil and water conservation methods are done in your location or area of work?………………………………………………………………………………………

(ii) Which soil conservation practicesare done by farmers in their cultivation?

………………………………………………………………………………………

(iii) What should be done to prevent further soil erosion in your land and the neighborhoods?…………………………………………………………………………

(iv) What are the limiting factors to better soil control and conservation?

………………………………………………………………………………………

(v) Who has the main responsibility for preventing further soil erosion?

………………………………………………………………………………………

10.(i) Are farmers in this Division accessible to agricultural extension service on agricultural

activities?………………………………………………………………………

(ii) If yes, above;

(a) How often?...

(iii) At what level? Village [ ] Sub-location [ ] Location [ ] District [ ] County [ ]

END

APPENDIX III: OBSERVATION CHECKLIST

Location…………………………………....

Sub-location……………………………….

1. (a) Land use.

Crops grown -

-Coffee ( ) - ( )

-Millet ( ) - ( )

-Maize ( ) - ( )

-Beans ( ) - ( )

-Cassava ( ) - ( )

Others………………………………………………………………………………

(b) Animals reared

Cows - [ ] [ ]

Goats - [ ] [ ]

Sheep - [ ] [ ]

2. Cultivation methods applied:

Shifting/fallow cultivation ( ) Contour cultivation/tillage ( )

Rotational cropping ( ) Intercropping ( )

Agroforestry/agronomic cultivation ( )

3. (i) Size of land under maize cultivation in hectares…………………………………

(ii) Average total land owned by households………………………………………

(iii) Number of household members…………………………………………………

4. Farm vegetation cover and type…………………………………………………

5. Soil and water conservation measures/methods……………………………………

6. (i) Communal erosion mitigation systems…………………………………………

(ii) Traditional mitigation systems……………………………………………………

7. Settlement patterns- Linear ( ) Clustered ( ) Scattered/sparse ( )

8. Topography of various areas- Very steep ( ) Steep ( ) Gentle ( ) Flat ( )

9. Estimation of soil loss- very severe- ( ) Severe ( ) Moderate ( ) Mild ( ) None ( )

10. Comparison of soil loss:

Type of soil erosion	Escarpment Tick appropriately	Kerio Valley(Tick appropriately
Splash		
Sheet		
Rill		
Gully		

END

APPENDIX IV RESEARCH AUTHORIZATION LETTER

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471,2241349
254-020-310571,2213123, 2219420
Fax: 254-020-318245,318249
when replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref:
NCST/RCD/10/012/29

Date:
19th October 2012

Michael Kandie Kangogo
Moi University
P.O.Box 3900-30100
Eldoret.

RE: RESEARCH AUTHORIZATION

Following your application for authority dated ***4th October, 2012*** to carry out research on "***The impact of soil erosion on maize production in Soy Division, Keiyo Marakwet County, Kenya.***" I am pleased to inform you that you have been authorized to undertake research in **Keiyo Marakwet County** for a period ending **31st December, *2012.***

You are advised to report to **the District Commissioners, the District Education Officers and the District Agricultural Officers, Keiyo Marakwet 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 M.K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:

The District Commissioners
The District Education Officers
The District Agricultural Officers
Keiyo Marakwet County.

"The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development".

APPENDIX V: CLAERANCE PERMIT

CONDITIONS

1. You must report to the District Commissioner and the District 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 with-out 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)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

GPK6055t3mt10/2011

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

(CONDITIONS–see back page)

PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Michael Kandie Kangogo
of (Address) Moi University
P.O.Box 3900-30100, Eldoret.
has been permitted to conduct research in

Location
District
Keiyo Marakwet County

on the topic: The impact of soil erosion on maize production in Soy Division, Keiyo Marakwet County, Kenya.

for a period ending: 31st December, 2012.

PAGE 3

Research Permit No. *NCST/RCD/10/012/29*
Date of issue *19th October, 2012*
Fee received *KSH. 1,000*

Applicant's Signature

Secretary
National Council for Science &Technology