MECHANIZED AGRICULTURE AND SOIL DEGRADATION: A CASE STUDY OF MOIBEN DIVISION, UASIN GISHU DISTRICT, KENYA.

BY

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DECLARATION

I, Olik Edward E. Ayacko, declare that this dissertation on **"Mechanized agriculture and soil degradation"** is my original work and has never been submitted to any university for any award.

Where the works of others have been cited, acknowledgements have been made.

Signature............................ Date...29th Sept, 2011...

OLIK EDWARD E. AYACKO.

APPROVAL

I certify that the work of this candidate has been under my supervision and is now ready for submission, to be evaluated for the award of a Bachelor of Science in Environmental Management of Kampala International University.

Supervisor.....Anne..... Date...03/10/11.....

MRS. ANNE TUMUSHABE

DEDICATION

This work is dedicated to my late sisters Sophie and Mercy, brothers Eric, Enoch, Erastus and Evance and my parents Mr. and Mrs. Nyayieyi.

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Abstract

Agricultural mechanization embraces the use of tools, implements, and machines for a wide range of farm operations from land preparation to planting, harvesting, on-farm processing, storage, and marketing of products while soil degradation is defined as the process which lowers the current and/or the potential capability of soil. This study was therefore to assess the degree of mechanized agriculture and its role in soil degradation in Moiben division in Uasin Gishu district, Rift Valley Kenya. The study was conducted among large mechanized scheme farmers and small holder farmers where the general objective was establishing the effects of mechanized agriculture on soil and specific objectives were to identify the agricultural mechanization technologies and equipment, to determine the activities involved in mechanized agriculture and to find out its effects on soil.

A descriptive study design in which both qualitative and quantitative methods were adopted. A total of 45 farmers were interviewed using interview guides, informal discussions based on questionnaires. Experimental research was also carried out to determine the effects of mechanized agriculture on soil. This was done by focusing on soil fertility whereby soil sampling was done and parameters such as determination of soil pH, measuring of soil organisms, measuring physical degradation and crop demonstrations followed. Data was analyzed, coded and presented using pie charts.

The study established that mechanized agriculture had an effect on the soil degradation and contributed to the downward decline of soil productivity through soil erosion, compaction, loss of organic matter and change of soil pH. I concluded that there was urgent need to protect the soils from degradation and from this I recommended use of organic farming, indigenous soil and water conservation, soil management and better systems and improvement on what is being practiced.

LIST OF ACRONYMS

DFID	DEPARTMENT FOR INTERNATIONAL DEVELOPMENT
FAO	FOOD AND AGRICULTURAL ORGANISATION
FDG's	FOCUS GROUP DISCUSSIONS
KWS	KENYA WILDLIFE SERVICE
MDG's	MILENIUM DEVELOPMENT GOALS
NPK	NITROGEN, PHOSPHOROUS AND POTASSIUM
OECD	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
SPSS	STATISTICAL PACKAGE FOR SOCIAL SCIENCE
UN	UNITED NATIONS
UNEP	UNITED NATIONS ENVIRONMENTAL PROGRAMME
UNESCO	UNITED NATIONS ENVIRONMENTAL SOCIAL AND CULTURAL ORGANISATION
R V P	RIFT VALLEY PROVINCE
AMS	AGRICULTURAL MECHANIZATION SERVICES

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE

1.0 Introduction

1.1 Back ground

Soil degradation is defined as the process, which lowers (quantitatively or qualitatively) the current and/or the potential capability of soil to produce goods or services. Soil degradation implies a regression in capability from a higher to lower state; a deterioration in soil productivity and land capability, (Mashali, 1991; Ayoub, 1991;UNEP, 1992 and Wim & Elhadji; 2002). Soil degradation can be observed in all agro-climatic regions on all continents. Although climatic conditions, such as drought and floods, contribute to soil degradation, the main causes are human activities. Soil degradation is a local problem in vast number of locations, but it has cumulative effects at regional and global scales. The countries of the developing world, and particularly those in the arid and semi-arid zones, are the most seriously affected, (UNEP 1986). Soil degradation can either be as a result of natural hazards or due to unsuitable land use and inappropriate land management practices. Natural hazards include land topography and climatic factors such as steep slopes, frequent floods and tornadoes, blowing of high velocity wind, rains of high intensity, strong leaching in humid regions and drought conditions in dry regions. Deforestation of fragile land, over cutting of vegetation, shifting cultivation, overgrazing, unbalanced fertilizer use and non-adoption of soil conservation management practices, over-pumping of ground water (in excess of capacity for recharge) are some of the factors which comes under human intervention resulting in soil erosion. The status of soil degradation is an expression of the severity of the process. The severity of the processes is characterized by the degree in which the soil is degraded and by the relative extent of the degraded area within a delineated physiographic unit (UNEP 1991).

The issue of soil degradation ranges from erosion and contamination of the topsoil to over abstraction and contamination of ground water. Soil degradation is an issue of growing concern in the world: 12% of total European land area has been affected by water erosion and a 4% by wind erosion (Dobris 2000). The loss of fertile soil itself degrades the productivity of the local agriculture. Also, the eroded soil being deposited downstream causes considerable damage to water management systems by filling up water storage reservoirs. Flash floods occur after torrential rains if water-absorbing capacity has been diminished for agro-economic reasons. About 115 million hectares are suffering from water erosion and 42 million hectares from wind erosion. The problem is greatest in the Mediterranean region because of its fragile environmental conditions. Soil erosion is intensified by agricultural intensification, but also by land abandonment and forest fires, particularly in marginal areas. Abatement strategies, such as afforestation, for combating accelerated soil erosion are lacking in many areas. (EEA 1998).

Soil degradation is also on the increase worldwide, especially in the countries within the tropics. Mismanagement of arable areas by farmers and grazing areas by livestock owners is one of the major causes of soil degradation. More sustainable management of soils would reduce degradation effects for example conservation tillage, i.e. reduced or no tillage, is the key to sustainable arable land management as it protects the soil resources, increases the efficiency of water use and, of special importance in semi-arid areas, reduces the effects of droughts (FAO 1999).Soil degradation encompasses several issues at various spatial and time scales. Acidification is the change in the chemical composition of the soil, which may trigger the circulation of toxic metals. Eutrophication may degrade the quality of ground water. Groundwater over abstraction may lead to dry soils. Atmospheric deposition of heavy metals and persistent organic pollutants may turn soils less suitable to sustain the original land cover and land use. (Scher & Yadav, 1994)

Agricultural mechanization embraces the use of tools, implements, and machines for a wide range of farm operations from land preparation to planting, harvesting, on-farm processing, storage, and marketing of products. Sources of farm power include hand tools, draft animals, and mechanically-powered technologies (Rijk, 1999). Agricultural mechanization often follows various stages, starting from the use of mechanical power for power-intensive operations that require little control (such as milling, threshing, water pumping, or land preparation, followed by control-intensive operations (such as harvesting, weeding, and adapting farming systems and cropping patterns) to increased use of mechanically powered technologies, and finally to automation of production.

Agricultural mechanisation may be looked at from different points of view. From the mechanical point of view, agricultural mechanisation may be described as the replacement of human labour with mechanical power. In as much as agriculture is an economic activity, the mechanisation of agriculture can also be seen in economic terms to be the replacement of labour with capital. From the farmer's point of view, agricultural mechanisation may be described as the proper choice and use of agricultural equipment from among the available alternatives.

Uasin Gishu District is basically an agricultural district, producing more than one-third of the total wheat produced in Kenya (DAO, 1996). Maize, a staple food for most Kenyans, is also produced in the District in large quantities, second to wheat. Agriculture, therefore, forms the main driving force for industrialization in the district and most industries within Eldoret (the headquarters of the District) are agro-based, utilizing raw materials from agricultural products.

1.2 Statement of the problem

Accelerating deforestation, soil erosion and other forms of soil degradation remain a major problem. Output from the fishing, agricultural and forestry sectors in particular has declined substantially because of soil degradation. Kenya's soils are diminishing fast at present as a result of clearance for agriculture, construction, tourism and industrial activities. The gradual conversion of land use to agriculture and other economic activities is also rapidly reducing the country's wide biodiversity; there are 35,000 known species of animals, plants and micro-organisms in Kenya (Kenya Wildlife Service KWS 2000). Water resources are under pressure owing to overuse, commonly for agricultural purposes. An increase in soil erosion is affecting agricultural productivity and contributing to the silting of dams.

Soil degradation is one of the major causes of low and in many places declining agricultural productivity and continuing food insecurity and rural poverty thus forcing farmers to resort to mechanized agriculture to increase yields and sometimes to generate employment. Achieving sustainable pathways out of the downward spiral of soil degradation and poverty requires that farmers adopt profitable and sustainable soil management practices, or pursue alternative livelihood strategies that are less demanding of the soil resource. Although there has been a great deal of effort to address soil degradation problems in Uasin Gishu, these have failed to reverse the downward spiral in much of the worst affected areas of the county. Part of the reason for this has been the promotion of practices and technologies that were not well suited to the conditions facing farmers in their particular location, and hence not profitable but excessively risky.

It is in the context of these economic and environmental impacts of soil degradation, and numerous functions of value of soil to humans that mechanization of agriculture and soil degradation concepts are relevant. The intensification of mechanized agriculture coupled with poor management accelerates the rate of soil degradation, resulting in serious forms of soil degradation such as loss of organic matter by fertilizer application, soil compaction during land preparation and harvesting, accumulation of salts by irrigation. Food supply situation will be worsened in the future if the current trend of soil degradation does not change drastically. The livelihoods of more than 900 million people in some 100 countries are now directly and adversely affected by soil degradation (United Nations, 1994). Unless the current rate of soil degradation is slowed and reversed, soils will be threatened and the ability of poor nations to increase their wealth through soil cultivation will be impeded. Hence due consideration needs to be given to the environmental concern of soil degradation; due to the limitation of soil resource on planet earth and the increasing imbalance of soil due to the great difference in the rate of soil degradation and the rate of its regeneration.

1.3 General objective

The general objective of this research was to find out the role of mechanized agriculture on soil degradation in Moiben division.

1.4 Specific objectives

1. To identify the agricultural mechanization technologies and equipment in Moiben division.
2. To determine the activities involved in mechanized agriculture in Moiben division.
3. To find out the effects of mechanized agriculture on soil in Moiben division.

1.5 Research questions

1. Are there technologies and equipment of mechanized agriculture in Moiben division?
2. Which practices are involved in mechanized agriculture in Moiben division?
3. What are the effects of mechanized agriculture on soil in Moiben division?

1.6 Scope of the study

1.6.1 Geographical Scope

The study was limited to Moiben division in Uasin Gishu County, a local authority which was in the Rift valley province of Kenya. Uasin Gishu is located 2.5 km from Eldoret. It is inhabited by the Kalenjins who form the majority of the people, however there are other minor communities like the Luos, Luhyas and others. The study was conducted in rural areas and urban centres where farmers practice their agriculture.

1.6.2 Content Scope

This study focused on mechanization of agriculture and soil degradation in farming communities finding out effects of mechanized agriculture on quality of water, biodiversity, soil quality and land management.

1.6.3 Time scope

The results were based on data for the period of the last five years 2005-2010. It was scheduled between May and September 2011.

1.6.4 Sample scope

The study targeted local farmers around Uasin Gishu as well as agricultural extension officers in the area that work collectively with farmers. The study also aimed at getting information from institutions that train individuals in the agricultural field. An example is Moi University of science and technology that is located in the area.

1.7 Significance of the study

The study would give focus and commitment from leaders and policy makers to develop policies that promote sustainable development which leads to conservation of biodiversity and natural resources on the farms.

To facilitate policy interventions, and given the crucial importance of soil classification, the location-specific aspects of soils; particular attention would be given to the spatial dimension of soil degradation, for example, by mapping the recommendation domains of desirable soil management technologies.

The findings of the study were intended to be a powerful tool for the Kenyan government in achieving Millennium Development Goals (MDG's) particularly those on environmental quality.

This research would generate knowledge on organic agriculture for example; improving our soils through addition of organic manure, conservation tillage. This would reduce impact of mechanized agriculture. This is significant to academicians and researchers who want to make discoveries in industrial agriculture.

CHAPTER TWO

2.0 Literature review

2.1 Definition of terms

A farmer

A farmer is a person, engaged in agriculture, who raises living organisms for food or raw materials, generally including livestock husbandry and growing crops such as produce and grain. A farmer might own the farmed land or might work as a labourer on land owned by others; but in advanced economies, a farmer is usually a farm owner, while employees of the farm are farm workers, farmhands, etc. (http://www.farmer.org May 20th at 9.30 pm 2011).

Soil

Soil has been defined in several ways depending on the context and perspective of the study. "Soil is an integral part of the Earth's ecosystems and is situated at the interface between the Earth's surface and the bedrock. It is subdivided into successive horizontal layers with specific physical, chemical and biological characteristics and has different functions. From the standpoint of history of soil use, and from an ecological and environmental point of view, the concept of soil also embraces porous sedimentary rocks and other permeable materials together with the water which these contain and the reserves of underground water." (Council of Europe 1990)

Agriculture

Agriculture is the practice of cultivating the soil and raising livestock to produce plant and animals useful to humans. (http://www.agriculture.org May 20th at 9.30 pm 2011).

Mechanization

Tools, implements, and powered machinery are essential and major inputs to agriculture. The term mechanization is generally used as an overall description of the application of these inputs (Clarke, 2000). Starkey (1998) defined farm mechanization as the development and introduction of mechanized assistance of all forms and at any level of sophistication in agricultural production to improve efficiency of human time and labour.

2.2 The concept of agricultural mechanization

Agricultural mechanization can be defined as the use of machines instead of human effort for agricultural production, processing, handling, preservation and storage. Agricultural mechanization is not an end but a means of eliminating drudgery in farming and eventually increasing food production.

According to Spore (2002), agricultural mechanization will bring about changes in production methods, logistics and equipment. There is the need to adapt processes and tools to the mechanics of elderly and youthful bodies alike. The ergonomics option involves technological development of production tools and equipment as well as improvement in the harvesting, handling and processing methods in order to reduce drudgery and make agricultural production processes more attractive.

Odigboh (2000) further defined agricultural mechanization as the use of a machine, any machine, to accomplish a task or an operation involved in agricultural production. Such tasks or operations, according to Odigboh, include reduction of human drudgery, improvement of timeliness and efficiency of various agricultural operations, bringing more land under cultivation, preserving the quality of agricultural products, providing better rural living conditions and markedly advancing the economic growth.

Agricultural mechanization embraces the manufacture, distribution and operation of all types of tools, implements and equipment for agricultural land development, farm production, crop harvesting and primary processing.

Within the historical and economic context, agricultural mechanisation has seven stages of evolution (Rijk, 1989; Speedman, 1992).

i. Stationary power substitution, where mechanical power is substituted for human power used in stationary process.

ii. Motive power substitution, where operation systems previously based on human power are replaced by mechanical power.

iii. Human control substitution, where emphasis is placed on mechanising operations previously controlled by human decision making.

iv. Adjusting cropping systems to the requirements of mechanisation (cropping system adaptation).

v. Adjusting farming systems to the requirements of mechanisation (farming system adaptation).

vi. Adjusting plant physics to the requirements of mechanisation (plant adaptation).

vii. Automation, where operations in agricultural production are fully automated.

2.3 The concept of soil degradation

Soil degradation is a long standing environmental issue linked to a wide variety of human activities, with known impacts reaching back millennia, e.g. in Mesopotamia, North Africa during Roman times, the dustbowl in North America earlier this century, and currently China and Africa in particular (Thomas & Middleton 1994). Often the effects of soil degradation become most evident during periods of adverse (dry) climate conditions as is evident in the examples cited. Soil degradation is not only linked to adverse climate changes; it has been shown to be an ongoing concern worldwide (Middleton & Thomas 1992, Syers et al.1996). As population pressure increases and societies change from one agrarian management practice to another, large-scale impacts on soil conditions tend to follow (Mabbutt 1989, Nicholson 1989, Hulme 1994, Syers et al. 1996, Warren et al. 1996). Most frequently these impacts result in vegetation change, top soil loss and the erosion of soil from arable lands, sometimes rendering these lands unsuitable for further agricultural use (Middleton & Thomas 1992, Hulme & Kelly 1993). The results of soil degradation include changes in local vegetation structure, soil water holding capacities, soil permeability and surface albedo (Bryant et al.1990, Schlesinger et al. 1990, Thomas & Middleton 1994).

2.3.1 Types of soil deterioration taken into account

The greatest threats to soil identified in the European Communication document "Towards a Thematic Strategy on Soil Protection" (European Commission, 2002) are:

- Erosion
- Contamination (point-source and non point-source)
- Salinization
- Decrease in soil organic matter
- Sealing
- Floods and landslides
- Compaction
- Loss of biodiversity

2.4 Agricultural mechanization technologies and equipment

Much of the controversy over agricultural mechanisation, both at academic and policy-making levels, has emerged from the fact that it is often considered only as the application of mechanical power technology, particularly tractors. However, three main levels of mechanisation technology need consideration: hand-tools, draft animals, and mechanical power technologies, with varying degrees of sophistication within each level (Rijk, 1989), on the basis of capacity to do work, costs, and, in some cases, precision and effectiveness (Morris, 1985).

2.4.1 Hand tool technology

Is the most basic mechanization level where a human muscle is the source of power utilizing simple tools and implements such as hoes, matchets, sickles, wooden diggers, etc. This level only produces a low and declining agricultural production and productivity. Mrema and Odigboh (1993) reported that about 86% of land preparation operations in Nigeria are carried out with hand-tools powered by human muscle .The power output of a human being is a maximum of 0.07kW. This is further limited by stress, especially at the high temperature and humidity conditions found in such a tropical country as Kenya. As a result, farming using manual power is arduous, inefficient and characterized by low rates of work.

The predominant form of rural technology is based on manual labour, with the hand hoe as a basic ingredient. The main attributes of this system are that it represents a low-cost, low-energy, labour-using, family-oriented technology, which is closely attuned to traditional and subsistent farming methods such as shifting cultivation and intercropping, and is largely self-sufficient and drawn on locally made implements (Morris 1985). Much of the agricultural production in poor rural communities emphasises risk minimisation and home consumption, with only a small part passing through market channels. Tools include axes and machetes for land clearing, hoes and steel digging sticks for seedbed preparation and tuber and root crop harvest, and sickles and knives for weeding and harvest. Other hand-powered tools include those for winnowing, rice polishing, maize grinding and candle nut, coconut and coffee processing. Most of these tools are present in any traditional household, both in upland and lowland communities. Given the simple nature of many traditional implements, much scope exists for increasing productivity by improved hand tools and man-powered machines. A recent study by Clarke and Bishop (2002) reveals that humans are the most significant power source in sub-Saharan African countries where 65%of the land is cultivated by human power. In central and western Africa, they account for an estimated85% and 70% of harvested area respectively, while the land cultivated by humans is estimated 40% in East Asia and 30% in South Asia.

2.4.2 Animal traction/ Draught animal powered technology

Involves the use of such animals as buffalos, oxen (in excess of 350 kgs), elephants, camels, horses, mules, and donkeys to pull specially designed implements for light tillage operations. This technology is not much in use, if at all, for such field operations as planting, weeding and harvesting though it has been vigorously promoted in sub-Saharan African countries since the 1920's.Draught animal powered technology is generally limited to the Sahel and Sudan savannah ecological zones (northern part) of Nigeria (Gwarzo, 1988). This level of technology is believed to be an improvement over the use of hand tool technology, because more work can be accomplished per unit time using work animals.

Animals used as draught animals are a relatively recent development in most of Sub Saharan countries. Ethiopia is an exception; here draught animal power has been used for centuries, while countries like Kenya and Uganda began utilising this technology first in the early 20th century. About 50per cent of the draught oxen in Sub-Saharan Africa are in areas where draught animal power was introduced this century and the other 50 per cent are found in Ethiopia (Ellis-Jones, 1996).

Animal power is still widely used in China, while Indian agriculture has been traditionally dependent on draft animal and human power as the major source of energy. During the 1960s, several newly independent African countries, among them Tanzania, Zambia, Guinea, Ghana, and the Ivory Coast, adopted policies that were designed to leapfrog the animal traction stage by providing tractors and tractor-hire services at subsidised rates. Most of these attempts at rapid 'tractorisation' failed and several countries subsequently reverted to encouragement of animal-draft power (Pingali et al., 1987). In countries with advanced levels of mechanisation, the use of animal power has been gradually falling and even totally displaced.

2.4.3 Tractor technology

In 1983, nine countries in Sub-Saharan Africa, including South Africa, had approximately 250,000 four-wheeled tractors. South Africa had 60 per cent of the whole quantity. Zimbabwe and Tanzania came second and third among the nine countries with 20,300 and 18,500 tractors respectively (Binswanger, 1987). Pimentel and Pimentel (1982) compare human, oxen and tractor (6 hp and 50 hp) energy-use ratios in tilling one hectare of soil. The conclusion is that a pair of oxen takes only 65 hours to till one hectare of soil, compared to 400 hours of manpower(using a heavy hoe), but expends almost 50 per cent more energy than man power tilling does. In addition, 6-hp and 50-hp tractors use much less time, 25 and 4 hours respectively, to till one hectare, but the total energy input is far greater than that for either man or ox-power. Compared to Morris (1983) these work rates are much lower, for animal and in particular human power. The reason for this variation is most likely differences in the method used, while carrying out the experiments. Pimentel and Pimentel (1982) continues taking the current prices of fuel, hay and labour in all countries, it is generally more economical to till the soil with either machinery or oxen than with manpower. Since, manpower is the most costly power source of them all. In contrast, if fuel prices rise, mechanical power may no longer be as profitable as it is today. Pimentel's and Pimentel's (1982) perspective is here entirely focused on energetic factors and almost entirely on the agriculture of the United States. Hence, mechanical power might be the most profitable in energy terms, but not in economical terms considering the poor repair and maintenance services available to most Sub-Saharan African small-scale farmers.

2.4.4 Agricultural mechanization equipment

Chaff Cutter

The seed casings and other inedible parts of the plant matter harvested with cereal grains such as wheat are known as chaff. Techniques such as threshing and wind winnowing are used to separate chaff from the grain before use. Hay, or straw is cut short by a machine called a chaff cutter and usually fed to cattle.

Lawnmowers

An instrument used to cut grass short to an even length is called a mower. It is used primarily to cut the lawn on sports grounds and expansive gardens. Using a mower is a more efficient way of making the length of grass uniform.

Plough

Plough is used initially for soil preparation and for sowing seeds or planting developed from the pick or the spade. Initially it used to be pulled by humans and later using cattle like oxen and bullocks. Modern day ploughs are attached to tractors. The benefits of ploughing land are to turn over the top surface of the earth. It also uproots weeds growing near the crops, thereby making soil more porous and easier for later planting. The common ploughs have sets of 2 up to 5 mould boards, but semi-mounted ploughs, the lifting of which are supplemented by a wheel about half-way along its length, can have as many as 18.

Elevator

A long piece of equipment which is powered by a tractor and used to move items such as small piles of hay and to store them in a barn are known as elevators.

Pumps and Pipes

A pump may be defined as a mechanical device that can be used to move or carry liquids and gasses from a low pressure area to a high pressure area. The earliest form of pump is known as the 'Archimedes Screw Pump. Pumps work by using mechanical forces to push a material either by physically lifting it or by using force of compression.

Pipes

They are usually made of polyvinyl chloride or copper and used to carry pressurized fresh water. They are usually available in straight lengths called joints or sticks.

Chisel plough

Is a common tool to get deep tillage with limited soil disruption. The main function of this plough is to loosen and aerate the soils while leaving crop residue at the top of the soil. This plough can be used to reduce the effects of compaction and to help break up plough pan and hardpan.

Tractor

The tractor, the most frequently used machine on the farm, has two large wheels at the rear that provide the power and two smaller ones at the front for steering, with an engine in the centre. Tractors come in many sizes and have a shaft at the back that turns and provides power to other machines that it pulls. Some tractors have front-end loaders - an implement for moving feed, manure or dirt, or for lifting heavy objects like large round hay bales. The cab of the tractor protects the driver from the rain, cold, wind, dust and heat; some even have air conditioners and sound systems, just like a car. Some tractors have four wheel drive - power to the front wheels as well as the back wheels; this adds to the usefulness of the tractor and it can be used during all seasons.

Cultivator

Cultivator is a farm implement for stirring and pulverizing the soil, either before planting or to remove weeds and to aerate and loosen the soil after the crop has begun to grow. The cultivator usually stirs the soil to a greater depth than does the harrow.

Chisel Plough

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Harrow

A farm implement consisting of a heavy frame with sharp teeth or upright disks, used to break up and even off ploughed ground Spike. The spike harrow or drag is a tillage implement for agriculture. It breaks up clods of soil that result from other tillage equipment such as the disk harrow or plough.

Seed Drill

The seed drill is used farmers to dig the land to sow seeds in well-spaced rows at specific depths.

Rice Transplanter

Rice Transplanter is a specialized transplanter fitted to transplant rice seedlings onto puddle field.

Combine Harvester

Combine Harvester or simply combine, is a machine that harvests, threshes and cleans grain plants. The desired result is the seed (such as canola or flax) or grain (such as oats , wheat , or rye); a byproduct is loose straw , the remaining husk of the plant with all nutrients removed.

Cotton Picker

Cotton Picker is a self-propelled machine that removes cotton lint and seed (seed-cotton) from the plant at up to six rows at a time. It uses rows of barbed spindles that rotate at high speed and remove the seed-cotton from the plant. The seed-cotton is then removed from the spindles by a counter-rotating doffer and is then blown up into a basket located on the picker

Backhoe

Backhoe is also called a rear actor or back actor, is a piece of excavating equipment consisting of a digging bucket on the end of an articulated arm (also called a stick or dipper).

Hand seed planter

A simple device for planting such seeds as maize, soya-bean, guinea-corn, etc. It consists of a seed tube, a funnel, a handle, a jaw-type soil opener and a plant spacing adjustment. It can drop two to four seeds from the seed funnels at a time.

Manual seed and fertilizer broadcaster

A multi-purpose low-cost device which can distribute granular materials such as seeds, fertilizers, pesticides, etc., with high degree of uniformity and precision. It comprises a cylindrical hopper with a conical bottom, a circular distributor disc, a gear drive mechanism, a hand crank, an agitator, a feed control lever and a strap for mounting the broadcaster on the shoulder. The output capacity of this broadcaster is 4 – 5 ha/day.

Improved long handle weeding hoe

A useful device or tool used for weeding and hoeing in the standing posture. The salient features include blade made of high carbon steel, long or short handle for any desirable posture during work, a rake that can be fitted to the same handle.

Rotary hand-guided weeding hoe

Is a push-pull type of weeder which is used for weeding and hoeing crops sown in line. Its main features include a rim made out of mild steel rods and cone bearings. The wheel hand hoe is meant for weeding and hoeing in the inter-row spaces of the crop planted in lines. It is not convenient to use it for crops planted on ridges. The work rate of rotary hand-guided weeding hoe is 0.03 - 0.05 ha/hr.

Cassava lifter

Is a simple device designed for uprooting cassava tubers. It consists of a frame to which a foot board and an immovable gripping jaw are attached, a lever (handle) which is hinged to the frame. The work rate of this device is about 2000 plants/man-hour under normal condition.

Tractor mounted groundnut digger

Is a tractor-mounted implement used in up heaving groundnut plants which are ready for harvest on the farm. This implement can be used on large scale or mechanized farm to reduce the intensity of labour during harvesting. It consists of cutting blades, which helps to cut the roots of the groundnut vines and loosens the soil. The average field capacity was found to be 0.53 ha/hr.

Groundnut decorticator

An equipment or device used for shelling of groundnut pods after harvest to obtain fine seeds. The main features of the equipment include a frame, hopper cylinder cum concave, an oscillating section and a handle. The output capacity is 40 - 50 kg/hr. The manually operated decorticator is ready for commercial release while the motorized version is under intensive testing.

Manual maize sheller

A very efficient and simple equipment for shelling maize cobs. It consists of galvanized steel and thick plates. It functions well on a small-scale farm (i.e. peasant farm). The output capacity is about 30kg/hr. The equipment is ready for commercialization.

Seed de-huller

Is a manually operated equipment with a capacity of 25 - 30kg/day. It is used to de-hull crops like cowpea and soya bean. The main features of this machine are screw on a shaft, a pipe, a hopper and a handle. It is affordable for most housewives.

Multi-purpose thresher

Can be used to thresh maize, rice, cowpea, guinea corn, and other grain crops. It has a capacity of 200 kg/hr (for cowpea). The main features of this equipment are the hopper, the threshing unit consisting of beaters welded onto cylinders and the concave. Medium, and large-scale entrepreneurs would find this equipment highly versatile.

Vegetable slicer

Used in slicing tomatoes, okra and carrot, and other vegetable crops. It has a capacity of 30 kg/hr, 20 kg/hr and 15 kg/hr for tomatoes, okra and carrot, respectively. Its main features are presser tray, frame and cutting blades. It can be used by housewives, and small-scale processors.

2.5 Activities involved in agricultural mechanization

A general description of mechanization (according to Ruthenberg, 1985) is given below.

(1) Preparatory activities

- land preparation
- preparation of plant material

(2) Planting / seeding

(3) Crop management

- fertilizer application
- irrigation
- thinning and weeding

(4) Harvesting

(5) Processing

Preparation of land

This is an important practice which helps to enrich the soil and make it more fertile and aerated. It involves addition of manure followed by turning, loosening and levelling of the soil, using agricultural implements like spade, plough or mechanical farm implements.

Planting

Is the placement of planting materials into the soil. The planting materials include: seeds, vegetative planting materials such as suckers for growing bananas.

Seed treatment

Seeds can easily be attacked by micro-organisms. The crops that grow out of diseased seeds will also be unhealthy. So farmers treat these seeds by dipping them in certain chemicals like *cerosan* or *agrosan.* These chemicals do not allow the microorganisms to attack the seeds and damage them. Such chemicals are called Fungicides. Once the seeds are treated, they can be sown

Land Grading and Levelling

The practice of land grading or land levelling consists of shaping the soil surface within a field to improve surface drainage and eliminate areas where surface water may pond. This is usually done by cutting high spots and filling low spots. The activity requires the use of cultivation and land levelling equipment such as scrapers and heavy tractors. Land grading is generally used to improve drainage but can be used to change the aspect of a site, remove 'bumps and hollows' or provide improved erosion control.

Preparing the seed bed and care of the seedlings

In certain crop plants like paddy and some of the vegetables, seeds are not sown directly in the main field. First these seeds are sown in a nursery bed. Once they grow to a certain age they are transferred and planted in the main field. These small plants are called seedlings.

Fertilizer application

Crops need nutrients like phosphorus, calcium, nitrogen etc. for their growth and pick up these nutrients from the soil. It is very important to add fertilizers to the soil. They provide nutrients to the soil and help to obtain a better crop yield. Depending on the type of soil and the crop to be grown, we use different fertilizers. The way we use a fertilizer also depends upon what type of fertilizer is being added to the soil. A fertilizer which contains nitrogen (nitrogenous fertilizer) is generally given in two or three doses. Other fertilizers are phosphatic and complex fertilizers. Some fertilisers are added to the soil before transplanting. You must have heard about the most commonly used fertilizer 'NPK'. The letter N stands for nitrogen, P for phosphate and K for potassium. While fertilizers are manufactured from chemicals in factories, manure is made from organic substances and contains nutrients in small quantities.

Use of plant growth regulators

Plant growth regulators are certain chemicals which regulate the growth of plants. All plants have growth regulators which determine how tall the plant would be, how big its fruit will be, etc. We can now add some plant growth regulators like *auxins, gibberellins, cytokinins, abscisic acid* etc. to get a better yield of crops.

Irrigation

Irrigation is necessary for proper development of plants. Roots fail to develop and penetrate in the dry soil. The crop is irrigated according to its requirement and soil characteristics. Irrigation is essential during the seedling, flowering and grain filling stages of the crop. Rice crop needs standing water.

Harvesting

Harvesting machines have now replaced the back breaking job of hand harvesting with the sickle and scythe. Harvesting machines cut or dig out the plant or its parts as required. The machines gather the plant parts, separate desired parts and eliminate parts not needed. Certain harvesting machines may even load the crop for transport. However, the above mentioned functions of harvesting machines depend on kind of crop, plant parts to be harvested, crop use, stage of maturity, etc.

Agro processing

Turning primary agricultural products into other commodities for market - has the potential to provide those opportunities. The overall potential of agro processing is huge. It can reduce wastage, enhance food security and reduce perishability of products.

2.6 Effects of agricultural mechanization on soil

Water use and availability. Irrigated agriculture is a major user of water and is crucial to the world's food supplies. One fifth of the world's cropland is irrigated, and this produces 40% of the world's food. In South Asia, over 80% of water resources are now used in agriculture. Despite great investment, water use efficiency in irrigation is generally very low and there are major concerns regarding its depletion and persistent conflicts over water rights. Unsustainable exploitation of groundwater may lead to unforeseen problems such as arsenic contamination of drinking water. And, in large areas of India, water tables are already falling as demand is exceeding the sustainable yield of aquifers. (DFID 2004)

Agriculture has contributed to soil erosion through certain practices such as land-use conversion, tilling or overgrazing. Major concerns are soil erosion caused by both wind and water in the United States and in the Canadian wheat belt, and water-related erosion problems in Australia, New Zealand and Mediterranean countries (OECD decade report 1993-2003)

Farming is currently a significant source of water pollution, which is a particular problem in certain regions of Europe and the United States, and at a local level in other countries including Australia, Canada and New Zealand. The application of fertilizers in agriculture and animal effluent from livestock account for as much as 40% of nitrogen and 30% of phosphate emissions in surface water in some OECD countries, contributing significantly to the problems of eutrophication, which results in the depletion of oxygen in water. Pesticide run-off from agricultural land also impairs drinking-water quality and harms water-based wildlife. (OECD decade report 1993-2003)

Irrigation accounts for a major share of water use in most OECD countries and excessive groundwater extraction levels are a concern in many areas, particularly the drier regions of Australia, Southern Europe, Mexico and the United States. Problems of Salinization are associated with land-clearing and irrigation in several countries, including Australia. (OECD decade report 1993-2003)

In many OECD countries agriculture has been identified as a significant cause of the loss of biodiversity, in particular leading to habitat degeneration through land-use changes caused by the intensification of farming practices (including larger field size, reduced crop rotations and increased fertilizer and pesticide application). However, abandonment of farming has led to changes in the habitats in a number of areas using specific farming practices. This is especially the case in Europe, where many of the most valued areas for wildlife tend to be semi-natural habitats, and species have co-evolved with traditional agricultural practices over many centuries. By contrast, in countries such as Australia, New Zealand and North America, valued habitats are predominantly associated with natural areas including grasslands, wetlands, native forests and bush. These areas have in some cases been put at risk by agricultural practices. For example, in the United States the conversion of grasslands and wetlands to cropland is judged to have contributed to the decline of several rare species of wildlife. (OECD decade report 1993-2003)

Uri (1990) suggests that cropping practices, pesticide and fertilizer strategies, and manure management are responsible for significantly degraded surface and ground water supplies in agricultural areas. He identifies the three main types of water quality impairment from agricultural practices as sedimentation, eutrophication, and pesticide contamination. During the Walkerton Ontario 2000 incident, the public became generally aware that pathogens such as the E-coli bacteria were also agriculturally based water contaminants (Mackie 2000).

(Friesen 1999) found that farmers in Manitoba are removing tree shelterbelts to increase their acreage and grow more crops. This is an example of how a short-term economic decision can override a standard and well established conservation policy. Although tree shelterbelts are known to combat or prevent wind erosion, the immediate gain caused by having slightly more arable land is affecting farmers' practices of controlling soil erosion.

Feedlots, typically used for beef, pork and poultry, confine animals in open-air or completely enclosed pens under controlled environments to optimize growth and the quality of meat and other products. They may generate large amounts of wastes that have the potential to cause pollution of water resources if improperly managed. The main sources of pollution from these facilities are the improper disposal of manure, animal carcasses, wastewater, feeding and bedding materials. Wastewater may be generated by the washing down of the facilities and runoff from manure stockpiles, and may be a significant source of pollution from feedlots. As well as nutrients, it may contain salts that have been added to the feed. With a well-managed facility, much of the wastewater is retained and treated; however, poor management practices can allow large amounts of waste to contaminate water resources. In developed countries, these intensive stock-rearing practices have been implicated in water-pollution incidents.

Traditional terrace systems have also been abandoned on steep slopes, while top-benching is frequently practiced in hilly and mountainous regions, thus-completely altering both the landscape and local hydrology. The decline of pastoralism, and reduction in livestock numbers, are likewise affecting soil conditions by reducing the returns of manure to fields, and by substituting forage crops and permanent pastures with annual crops, which provide less complete soil cover and less effective
protection against erosion. Together, these changes are undoubtedly affecting soil fertility, and/or be encouraging soil degradation in many areas of the Mediterranean region. (Giordan 1992)

Water and wind erosion. They are often accelerated by inappropriate ploughing and tillage practices which interact with natural pedogenesis and induce soil erosion. As mentioned by the maximum rate of erosion compatible with maintenance of soil productivity is approximately 10 tons per hectare intemperate climate. (OECD 1991)

Soil compaction. Soil structure can be damaged by use of heavy farm machinery which compact the soil and reduce its permeability. (FAO-UNESCO, 1980).Harvesting and cane extraction during wet conditions is an unavoidable practice in many cane growing areas and uncontrolled infield traffic will cause most of the damage in terms of soil compaction, sealing/capping and physical damage to cane stools. The effect tends to be exacerbated in irrigated areas where there has been insufficient drying off before harvesting or where soils are not adequately drained. In South Africa, Maud (1960) showed that, for most sugar belt soils, the tendency to become compacted is greatest when their moisture content is near field capacity when land is dry. The effect tends to be exacerbated in irrigated areas where there has been insufficient drying off before harvesting or where soils are not adequately drained.

Intensive fertilization may bring the soil towards undesirable side-effects such as accumulation in the soil of heavy metals and phosphates. (FAO-UNESCO, 1980).

Water logging is caused by over irrigation, and restricted infiltration of water into the soil. This lowers soil productivity through rise in ground water close to the soil surface. (Mbagwu 1992).
Lowering of the water table is brought about by pumping of ground water for irrigation which exceeds the natural recharge capacity. Pumping of water for urban and industrial use also causes this form of land degradation. (Mbagwu 1992)

The results of a more recent investigation, based on the use of a soil profile acidification model, have shown increased soil acidification on an estate in Zululand and other areas (Schroeder *et al.*, 1994). Accelerated acidification of soils under cultivation is most often due to the combined effect of oxidation of ammoniacal fertilizers nitric acid, mineralization of organic matter and leaching of basic cat ions from the soil. Although the rate of soil organic matter loss has not been specifically researched, its role in Nitrogen (N) mineralization has received considerable attention (Wood, 1965) and any loss inorganic matter will seriously impact on the N mineralization potential of soils.

A more recent study of a cane yield decline in Swaziland showed that, under a system of monocropping, there was a deterioration in both physical and chemical properties of soils when compared with adjacent virgin land (Henry, 1995)

2.7 Conceptual framework

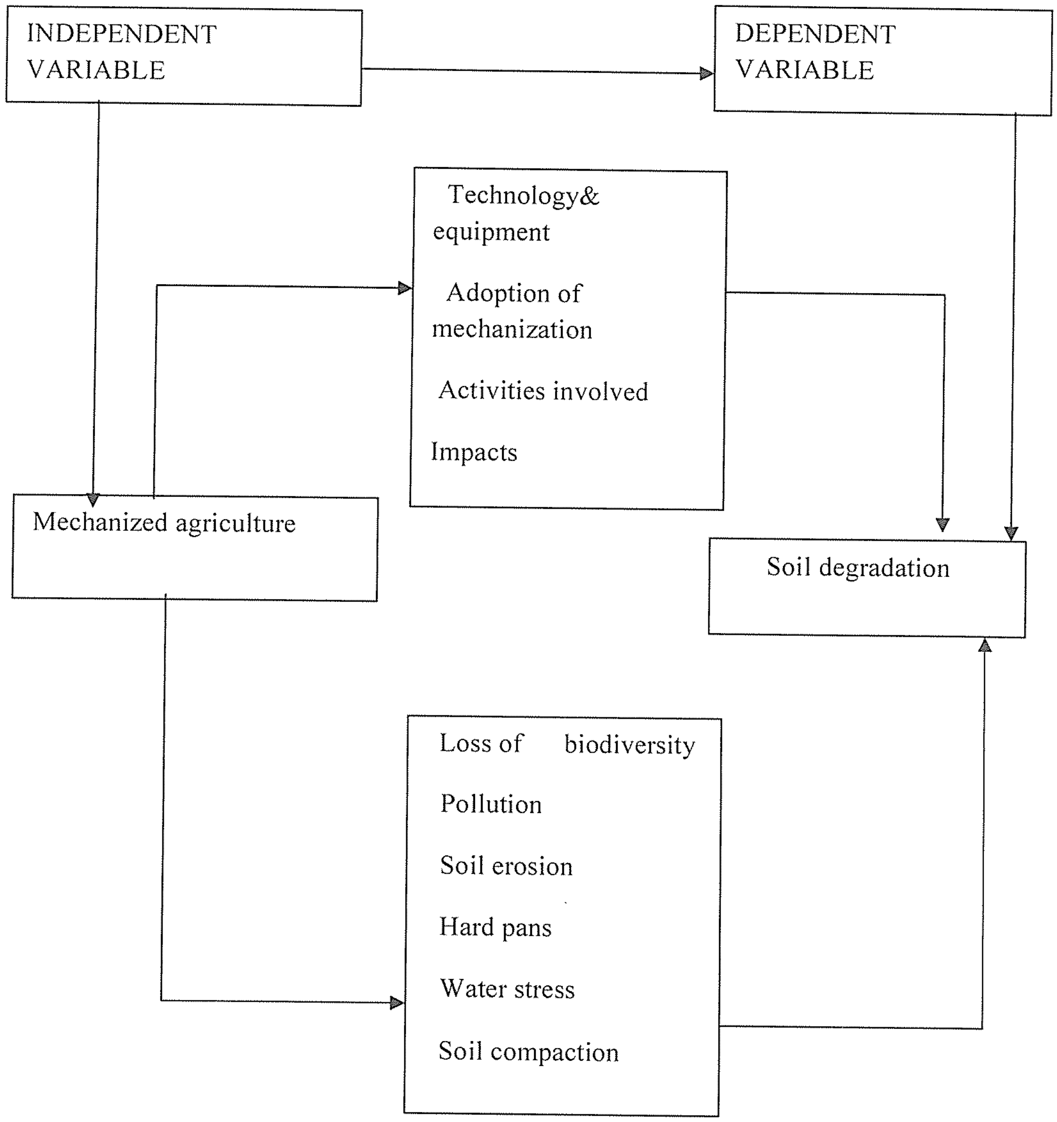


Figure 1

Source: Researcher 2011

CHAPTER THREE

3.0 Methodology

3.1 Research design

The study used both quantitative and qualitative research methods.

3.1.1 Quantitative method

A cross — sectional survey research approach was applied because the sample size was large and varied, and was also spread over a large area, which required some self report methods such as questionnaires. Basically, in this method, interview schedule and focus group discussions were applied.

The other approach was the case study. This was used concurrently with the cross sectional survey. Because of limited time and resources, this method was the most appropriate to use in particular cases to investigate the issue in question.

3.1.2 Qualitative method

Library research and review of documents pertaining to the issues under investigations (desk research) was done. This method was very necessary in order to analyze the existing literature on the variables in my study. It was also the approach used in conducting focused group discussions (FGDs). In this method, interview, observations and content analysis were used. This was because these methods were the most appropriate in gaining information from the study population that was basically rural and illiterate, but could speak for themselves.

3.2 Study area

3.2.1 Location of the study area

The study took place in Moiben division in Uasin Gishu district.

Uasin Gishu county is located in mid west of the Rift Valley Province and borders six counties, Elgeyo Markwet to the East, Trans Nzoia to the North, Kericho to the South, Baringo to the South East, Nandi to the South West and Bungoma to the West.

The capital city of Uasin Gishu is Eldoret (established in 1908 by fifty eight families of Afrikaans who trekked to the Uasin Gishu plateau from Nakuru after a journey from South Africa by sea).

There was also a large population of white immigrants from Zimbabwe, Scotland, England and South Africa who have settled and farm in Uasin Gishu County.

Uasin Gishu District is one of the Seventeen (17) districts in Rift Valley Province (RVP), with a total area of 3,327.8Sq.Km2. It extends between longitude 34° 50′ and 35 ° 37′ east and 0° 03′ and 0° 55′ north.

3.2.2 Administrative units

The district shared common borders with Trans Nzoia District to the north, Marakwet and Keiyo to the east, Koibatek District to the southeast, Kericho District to the south, Nandi to the west and Lugari District to the North West. The district is divided into six divisions namely Kapsaret, Ainabkoi, Kesses, Soy, Turbo and **Moiben**. It is further divided into 35 locations. (District Statistics Office, Eldoret, 2001)

3.2.3 Demographic and Population Profile

The 1999 population census showed that Uasin Gishu District had a population of 622, 705 with a growth rate of 3.35% p.a. The population growth rate is on a general decline from the inter-censal rate of 3.93% per annum for the period 1979 – 1989.

The district population is projected to increase from 622,705 recorded in 1999 to 682,342 people by the year 2002 to 729,079 people by the year 2004. This will increase further to 780,187 people by the year 2006. By the 2010 the population is projected to increase to 829,046 people. At annual growth rate of 3.35 per annum, the district population growth rate is higher than the national average of 2.9% per annum. This growth rate will continue to have negative effects on the provision of services to the people if left unchecked. (District Statistics Office, Eldoret, 2001)

3.2.4 Climate

The Uasin Gishu has a cool and temperate climate.

3.2.5 Soils

It was characterized by arid and fertile farmland, flat parched plains and steep ridges.

3.2.6 Economic activities

Agriculture: Large Scale Maize farming, Dairy Farming

Industries; manufacturing and agro processing

3.2.7 Agricultural Potential

About 90% of the land area of Uasin-Gishu district was arable land within the LH agro eco-zone.

About 2,000 km of the district was high agricultural potential and approximately 1,000 km is medium agricultural potential.

3.2.8 Relief

These were also the agricultural extension divisions. Swamps, rocks and hills cover the remaining 218 km.

3.3 Study population/target population

This study targeted farmers and extension officers totaling to 50, the sample size was derived at by using of sampling technique that ensures that each farmer and extension officer gets a chance of participating in the study.

3.4 Sample and sampling procedure

The sample size was 48 farmers of whom 3 were purposively sampled (extension officers) and 45 were randomly sampled from the field.

The sample was arrived at using the Yamane's formula (1967) of sampling.

$$n = \frac{N}{1+Ne^2}$$

N : Population of the study

n : Sample size

e : degree of confidence level at 95% which equals to 5%

$(n = N/1 + N(e^2)$

Where n = simple size, N = Constant, e^2 = level of significance = 0.05.

According to Oso and Onen (2005) in applying purposive sampling the researcher decides who should be included in the sample, it is used to collect focused information, typical and useful cases are selected.

All the 3 extension officers were included in the sample. The three are; - crop, animal and mixed farming extension officers.

This research was a stratified sampling technique to select farmers and extension officers from various departments that were included in the sample. Stratified sampling technique is a technique that identifies subgroups in the population and their proportions and select from each subgroup to form a sample (Oso et al 2005).

It grouped a population into separate homogenous subsets that share similar characteristics so as to ensure equitable representation of the population in the sample. The differences in case were the departments. The researcher applied purposive sampling in obtaining the respondents from the fields, their areas of concentration or department.

Table 1 How a sample of respondents was arrived at.

TYPE OF FARMER	TARGET POPULATION (Farmers)	SAMPLE SIZE (Farmers)	EXTENSION OFFICERS
Crop farmers	25	24	1
Livestock farmers	10	10	1
Mixed farmers	15	14	1
TOTAL	50	48	3

Source: researcher 2011

3.4.1 Sampling

The researcher used probability sampling method and in particular stratified sampling. In probability sampling every element in the population had a probability of being selected while in stratified sampling that the researcher used, he divided the population into sub-populations such that elements within these sub-populations were homogeneous. Then he selected simple random sample independently from each sub-population. The strata was based on farmers who practice mechanized agriculture and those that did not.

3.5 Research instruments

The collection of data in the study involved four types of research instruments namely: The interview schedule and self-administered questionnaire.

3.5.1 Interview Schedule

This was a set of questions that were prepared by the researcher to guide him when conducting interviews that it involved oral administration of the questionnaire and this schedule was used to get some information not captured by the self-administered questionnaires and also clarified on unclear issues.

3.5.2 Questionnaires

A self-administered questionnaire was used to collect data from farmers because most of them easily answered the questions. However, a special interview schedule was used to collect very important information from key informants (extension officers). Structured and unstructured questions were largely be used in order to get in depth information and experiences from the respondents.

3.5.3 Documentary Review

The researcher reviewed farm records in order to get the data needed for the study. He also reviewed articles, internet, books and documents to obtain information about mechanized agriculture, soil degradation and the history of the area. Data on soil characteristics and crop yields were overviewed over seasons for each individual site.

3.5.4 Observation

The researcher watched the systems in practice that he was taken through and the activities which farmers follow in mechanized agriculture and how they cause soil degradation. The researcher also observed deficiency symptoms in crops such as yellowing of plant leaves, stunted growth which were indicators of loss of soil fertility. Areas affected by erosion were also observed.

While in the field, observation of the existing forms of land use and soil degradation were made. For example, observation of certain features like gullies due to erosion and removed ground cover and farming practices were made. The nature of degradation was identified through typical soil degradation indicators such as soil erosion.

3.6 Experimental approach of methodology

To measure the effect of mechanized agriculture on soil, the researcher focused majorly on soil fertility. To measure this parameter, it was achieved through soil sampling.

3.6.1 Soil sampling

In representative farms of Moiben, four parcels, adjacent to each other, were selected according to the years of degradation. At each sampling point, two vertically crossing lines and two concentric circles of radius 3 and 6m will be drawn. An auger (7cm diameter) was used to take four cores of soil from the 0-20 cm depth in the small circle and eight in the outer circle. The 12 subsamples were homogeneously mixed to constitute a composite sample from which 500g soil will be taken, placed in a plastic bag, and double sealed and then kept under shade. The soil auger was sterilized with ethanol between sampling points to avoid cross contamination. The soil samples were transported to the laboratory where they were kept at room temperature before isolation before carrying out soil pH determination, measuring physical degradation, measuring soil organisms, and crop demonstrations for physical and chemical measurements.

3.6.2 Determining pH

Using a litmus paper, the researcher used a small sample of soil and mixed it with distilled water, into which a strip of litmus paper was inserted. If the soil was acidic the paper turns red, if alkaline, blue.

Observation of symptoms that might indicate acidic or alkaline conditions, such as occurrence of plant diseases in acidic conditions such as salinization of alkaline soils was also used. In addition the presence of nematodes in acidic soils indicated low soil pH. Another example was the house hydrangea (*Hydrangea macrophylla*) which produced pink flowers at pH values of 6.8 or higher and blue flowers at pH 6.0 or below.

3.6.3 Determining physical degradation

An easy way to see physical soil degradation was taking some small soil clods of about 1 cm diameter from a ploughed field and from a virgin area nearby. The researcher looked at both soil samples and it was generally easy to see the darker soil colour of the un-ploughed sample (higher organic matter content). The researcher dropped those clods carefully into a bowl of water and observed how the ploughed soil disintegrated while the unploughed soil stayed intact (this worked well with clay or loam soil than with sands that had very weak structure).

3.6.4 Measuring soil organisms

The researcher dug up some soil with a spade in a ploughed field and in an unploughed area and looked at the difference in number and diversity of fauna species. Generally you would see more organisms and more crumbs (aggregates) in the unploughed field.

3.6.5 Crop/field demonstrations

The researcher planted crops on two types of soils; where mechanization had been practiced and one where it had not been. The researcher monitored the growth habits of such crops, their characteristics like vigour, colour, in order to determine the extent of soil degradation. When those crops were harvested the researcher measured their biomass to determine their yields to determine the extent of loss of soil fertility.

3.7 Data analysis and presentation

Data analysis was done after the collection of the required information from the participants in the study. Data analysis was done both quantitatively and qualitatively.

3.7.1 Quantitative Data Analysis

After collection, data was edited to check for uniformity, consistency, legibility and comprehensiveness. It was then be coded by assigning numbers to different questions for easy analysis. After this exercise, data was finally analyzed using a computer program called Statistical Package for Social Sciences (SPSS). In this program, frequency tabulations and cross tabulations then worked out. The edited and coded data was then be arranged in tables, charts, and graphs to help deducing the required information regarding the study.

3.7.2 Qualitative Data Analysis

Analysis of qualitative data was done during data collection, by assigning different categories to different kinds of information. Content analysis was also used in cross- checking questions with similar others to ensure the validity and authenticity of the answers given. All information was then analyzed according to the set research questions and other relevant information captured to allow validation of the objectives.

3.8 Validity and Reliability of the research instruments

3.8.1 Validity

A pilot study was conducted among the sampled population. The purpose was to access the worthiness of the instruments to generate correct data so that items discovered to be inappropriate in answering the research questions and attaining the research objectives were modified to improve the quality and the appropriateness of the instruments or be discarded.

3.8.2 Reliability

Reliability refers to the consistency that an instrument demonstrates when applied repeatedly under similar conditions (Kerlinger,1983). The reliability of the research instruments was established by the researcher before analysis and consequent presentation. This was achieved by comparing the pilot and final data collected. The same instruments were presented to experts from Kampala International University inclusive of the supervisors for careful scrutiny.

3.9 Research procedure

The researcher obtained an introduction letter from Kampala international university school of Engineering And Applied Sciences to Moiben Farming Villages in Uasin Gishu District authorities to allow the researcher to conduct this study and permission will be sought from the authorities of Moiben Farmers Co-operatives to allow the researcher to conduct this study, participants willing to provide information were guided in the questionnaire filling process, and questions were asked by the researcher for clarification.

3.10 Ethical Considerations

The researcher maintained the privacy and confidentiality of the respondents, that is, keeping their personal issues private and also non disclosure of responses from particular respondents in order to maintain integrity and also protect them from potential victimization.

CHAPTER FOUR

RESEARCH FINDINGS, DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This chapter deals with the analysis, interpretation and presentation of the research findings. The analysis and research findings were interpreted and analyzed basing on the research questions. The study was set to investigate the impact of mechanized agriculture on soil in Moiben division, Uasin Gishu district. The findings were obtained through the use of questionnaires, interviews, documents, experiments and observation from Moiben farming villages was used as the case study.

4.1 The response rate

Table 2

Category of Respondents	Planned Responses	Actual Responses	Non-Responses
Field extension officers	03	--	03
Local farmers	45	45	--
Total	**48**	**45**	**03**

(Source: Field 2011)

The results showed that not all the intended respondents were positive although the ones who responded were 45 which was an adequate proportion of the sample size. The non-response was as a result of some extension officers being unavailable. There was also accessibility problems as some of the targeted respondents (extension officers) were never reached as scheduled.

4.1 Background information of the respondents

Table 3

Level of education	**Frequency**	**Percentage**
Primary	07	16%
Secondary	10	22%
Diploma	12	27%
Bachelors Degree	15	33%
Masters	01	02%
Doctorate degree	--	00%
Total	45	100%
Gender	**Frequency**	**Percentage**
Male	30	67%
Female	15	33%
Total	45	100%
Age group	**Frequency**	**Percentage**
Below 30	10	22%
30-40	20	44%
Above 40	15	34%
Total	45	100%
Number of years lived by respondents in the place	**Frequency**	**Percentage**
Less than one year	02	04%
1-5 years	05	11%
6-10 years	10	22%
Above 10 years	28	63%
Total	45	100%

(Source: field 2011)

Most farmers (33%) at Moiben had attained degree level of education while (27%) had diploma, (22%) had secondary school certificate, (16%) had primary school certificate and the lowest being those with masters (02%) while there was no one with doctorate degree. The researcher could therefore tell that farmers with high education level as those with degree were the majority while those with masters being the minority. The researcher could also identify that those farmers with higher education level like masters had long working experience and were the ones holding senior positions like farmers' chairman.

Majority of the respondents were male. It could be noted that, (69%) of the respondents and (31%) were male and females respectively. This literary implied that the farmers composed of mostly males than the females in Moiben division.

It is evident from the table that most respondents were in the middle age group between 30 and 40 which represented (42%) followed by age group above 40 with (38%) while the group 30 and below had (21%). The high percentage of the respondents between the age group of 30-40 years could be attributed to the reason that they are in the family setting and need to take care of their families.

The number of years spent by the respondents in the area varied from year to year. Majority of the respondents who lived for over 10 years had (65%) while those who lived between 6-10 had (21%) were some of the highest recorded. Years 1-5 was lower with a percentage of (10%). Below one year recorded the lowest with (04%) since they were new to the place. The higher number of years lived the place by the years above 10 could be attributed to be the residents of the area compared to those of years 10 and below. However this reason cannot be attributed to the same when compared to those of years 10 and below. Most of them within 1-10 years may have just entered into the area and are still establishing themselves.

4.3 Mechanization technology and equipment

4.3.1 Mechanization technology adopted

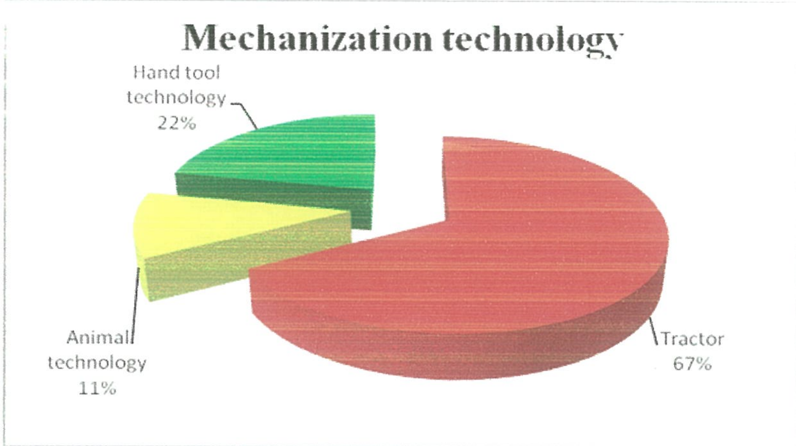
There were three major agricultural mechanization technology observed by the researcher and they included tractor, draught animal powered technology and hand tool technology as shown in the table below.

Table 4 Mechanization technology

Mechanization technology	Frequency	Percentage
Tractor/engine powered technology	30	67%
Draught animal powered technology	05	11%
Hand tool technology	10	22%
Total	45	100%

(Source: field 2011)

Pie chart showing the mechanization technology adopted by the farmers



(Source: field 2011)

Figure 2

According to study findings in figure 1, it was established from an analysis made from the respondents' reactions that tractors (67%) were the major mechanization technology adopted, followed by hand tools (22%) and draught animal technology (11%). According to the respondents it was reported that tractor technology (67%) was a major preference of mechanized agriculture. This was because the farmers owned vast pieces of land of over 10 acres which was economical to use the tractor. Farmers who used the tractor had the following reasons for its adoption; Good for large scale farming, good source of farm power, tractor is able to perform a number of operations for example planting and cultivation among others. The hand tool technology followed with (22%) since most of them were small scale farmers as well as subsistence farmers and had small pieces of land hence adopted simple tools like jembes. The hand tool technology was accessible to all farmers since they were cheap and affordable unlike the tractor which at times required hiring or buying at very high costs. Draught animal technology (11%) was the least mechanization technology adopted because the animals kept by the farmers majorly were cows kept for milk and sheep which could not facilitate activities such as land clearing.

(Source: field 2011)

Plate 1: Four wheeled drive tractor

Mechanization equipment

The study aimed at finding out the types of mechanization equipment and were summarized in table 5.

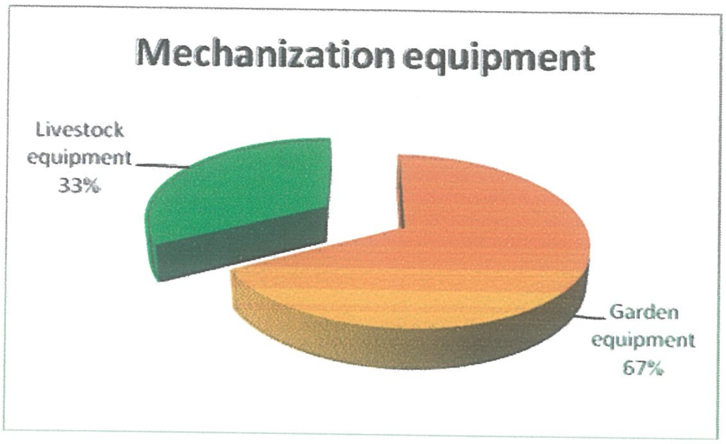
Table 5 Mechanization equipment

Equipment	Frequency	Percentage
Garden equipment	30	67%
Livestock equipment	15	33%
Total	45	100%

(Source: field 2011)

The information collected from the field revealed that the equipment were categorized into garden equipment (67%) which included ploughs, planters, combined harvesters and harrows and livestock equipment (20%) which included cattle dips, seed drills, animal carts and ox plough.

Pie chart showing mechanization equipment



(Source: field 2011)

Figure 3

From figure 2 above it was deduced that most farmers used the garden equipment (67%) since many of them were crop farmers and garden tools were suitable for them to carry out different management practices pertaining to crop production. Livestock equipment came second (33%) implying that they were moderately used by mixed farmers and those that reared livestock in their farms.

Plate 2: Trailer for transportation purposes   Plate 3: Mould board for deep ploughing of land

Plate 4: Maize sheller for removing maize from the cob

Plate 5: Spring tine harrow for breaking large soil clods

Plate 6: Planter for placing seeds and fertilizers in the soil

Plate 7: Combined harvester for harvesting crops such as wheat and maize

4.4 Activities involved in mechanized agriculture

The researcher investigated the activities entailed in mechanized agriculture. The results were as follows;

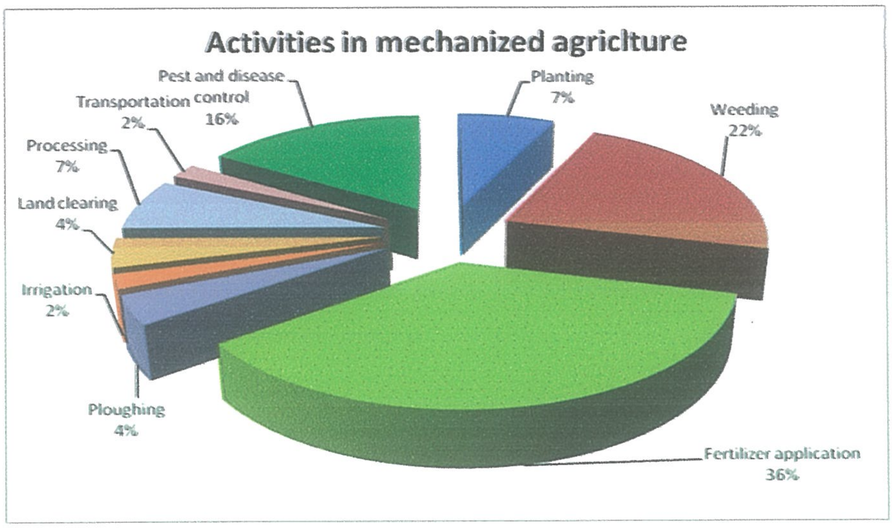
Table 6 Activities involved in mechanized agriculture

Activity	Frequency	Percentage
Planting	03	07%
Weeding	10	22%
Fertilizer application	16	36%
Ploughing	02	04%
Irrigation	01	02%
Land clearing	02	04%

Processing	03	07%
Transportation	01	02%
Pest and disease control	07	16%
Total	45	100%

(Source: field 2011)

Pie chart showing activities of mechanized agriculture



(Source: field 2011)

Figure 4

From the field, (38%) of the respondents revealed that the use of fertilizers in figure 3 was mostly preferred by the farmers for mechanized farming. This was attributed to the fact that most of the farmers were equipped with the fertilizer spreaders and planters, therefore it was easy for the farmers to apply to a mass area at a low cost hence increasing their revenue, yields and profit arising from high production. (22%) of the respondents revealed that weeding was to target weeds at every growth stage of the crops they planted in order to reduce competition with plants for space, nutrients and light. The farmers applied herbicides mostly selective herbicides that eradicate weeds and leave the main crop surviving. Some farmers used pre-emergence herbicides to control weeds before plants emerged after planting and post emergence after the plants had already emerged or germinated.

The results showed that (18%) of the respondents used pesticides and fungicides. It was found out that farmers could observe the pests and disease symptoms like leaf rust in wheat once they made a visit to the farms. They argued that chemical pest and disease control was very effective and efficient.

Planting and processing obtained (07%) each. According to the findings the respondents revealed planting was done after ploughing and harrowing. The farmers used planters and seed drills which dig, deposit and cover the seeds at the same time. This was common to farmers who had large tracks of land. Processing was done after harvesting the crops. It was made easier by the combined harvester which harvests and processes the produce with its internal chambers which separates chuff from grains. This was a common activity in maize and wheat crops.

Ploughing and land clearing were at (04%) each. Ploughing involved primary cultivation, secondary tillage and tertiary operations such as rolling (firming the soil to prevent small seeds from being blown by wind) and breaking of hard pans. The farmers did ploughing depending on the mechanization technology they had such as tractor, draught animal and hand tools. Land clearing was majorly done when making land ready for growing crops. In land clearing, the farmers used slashers, matchets, pangas and herbicides to clear vegetation. Other farmers carried out tree felling using power saws and axes and also removed tree stumps from the field.

Transportation and irrigation tied at (02%) each. Transportation was mainly done to ferry planting materials such as seeds, fertilizers and equipment. Transportation was also common when conveying crop produce from the field to the homestead or from the farm to the market. It was commonly done using a trailer mounted onto a tractor or using animals such as donkeys to pull carts. Land clearing was relatively lower because it was mainly done at the initial stage and was done once while transportation came last since most farmers could not afford tractor trailers and animal carts. Irrigation was done but on rare occasions to supplement rain water during dry seasons. The farmers used hose pipes and "money maker pumps" to apply water on the soil by overhead means.

4.5 Effects of mechanized agriculture on soil

The researcher sought to know whether mechanized agriculture had affected the quality of soil in Moiben division. The researcher used experiments such as measuring soil pH, observing crop yields, plant demonstrations, interviewing and questionnaires to obtain results.

Table 7 Response on impacts of mechanized agriculture on soil

Impacts of mechanization	**Frequency**	**Percentage**
Positive	15	33%
Negative	30	67%
Total	45	100%

(Source: field 2011)

From the above table it was deduced that most farmers were aware of the effects of mechanized agriculture. (67%) of the respondents said that the impacts of mechanized agriculture were negative while (33%) said that the effects of mechanization on soil were positive. Those against the effects of mechanization argued that some farmers practiced mechanization for their own economic gains hence not caring about soil conservation. There was also massive mono culture since the farmers were growing only one type of crop continuously leading to depletion of soil nutrients. Those in favour of mechanization suggested that practices such as fertilizer application enriched the soil with nutrients. in addition, tillage/cultivation opens up the land allowing percolation of water and circulation of air into the soils.

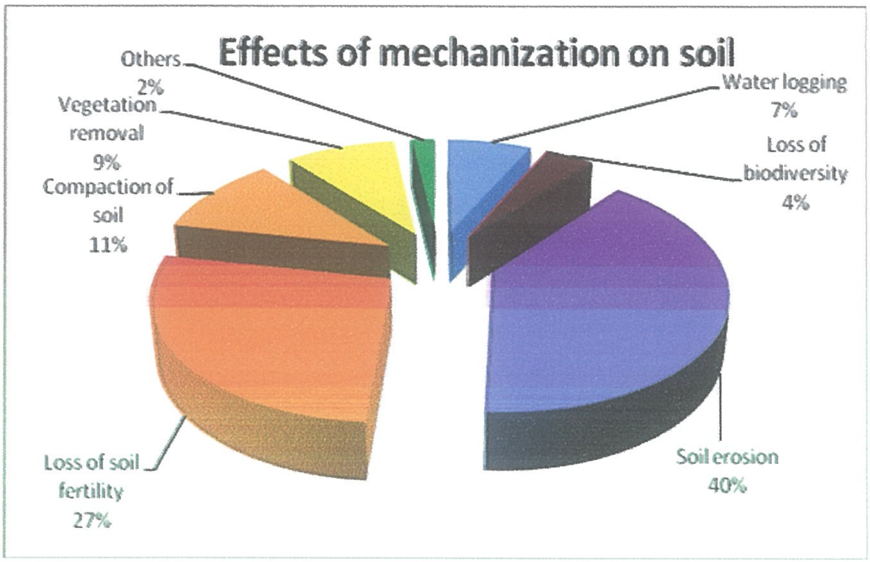
Table 8 Effects of mechanized agriculture on soil

Effects of mechanization on soil	**Frequency**	**Percentage**
Water logging	03	07%
Loss of biodiversity	02	04%
Soil erosion	18	40%
Loss of soil fertility	05	27%
Compaction of soil	12	11%
Vegetation removal	04	09%
Others	01	02%
Total	45	100%

(Source: field 2011)

According to the study findings in table 7 it was noted from the respondents that mechanized agriculture had numerous impacts which were established as; soil erosion (40%) which was the major impact, loss of soil fertility (27%), compaction of soil (11%), vegetation removal (09%), pollution (07%), loss of biodiversity (04%) and others (02%) which included loss of organic matter which was the least represented.

Pie chart showing effects of mechanization of soil



(Source: field 2011)

Figure 5

From figure 4, Respondents were asked about how they perceive ecological changes in the study area. All the farmers interviewed recognized the existence of land degradation in their fields. Based on their answers, farmers were also asked to mention the indicators or criteria which they used to identify the incidences of soil degradation in the area. The researcher identified soil erosion (40%) as the major impact of mechanized Agriculture on soil. Soil erosion in association with other factors was the most visible way in which soil degradation affects production in the study area. This view was also expressed by the group during the transect walk in Moiben division One farmer among the mechanized scheme farmers said: "Our faces are made brown (dirty) and wrinkled by the wind", meaning that wind erosion takes place on their farms.

The farmers' perspective was therefore articulated through how production was changing and the way in which plants, soil, water supplies and natural vegetation have deteriorated making production more problematic. Respondents mentioned rills, gullies, pedestals, armour layer, plant or tree root exposure, exposure of below-ground portions of fences and other structures (soil accumulations around these structures were also reported), rock exposure, sedimentation in drains, loss of topsoil and also the prevalence of *Striga hermontica* (witch weed) as main evidence. Results from the transect walk also confirmed that *Striga* was a problem in the Moiben area. Prevalent in the study area were two types of erosion, viz: wind erosion, prevailing in the dry season, and water erosion, prevailing during the rainy season. Erosion has also caused increased problems with pests. "*Striga* appears to thrive best on heavily used soils of less fertility. It leads to reduced crop productivity", a group of mechanized farmers said.

Loss of soil fertility encountered (27%). The soils lost their fertility as a result of massive monoculture where farmers grew one type of crop every season especially maize and wheat. The lands were not given adequate fallowing period after harvesting. There was no practice of crop rotation as one of soil management measures. Crop removal after harvesting also contributed to loss of soil fertility. In this research, the researcher focused majorly on assessing soil fertility loss and the following parameters were measured: soil pH, soil colour, soil odour, compactness, yield, flora of the soil, physical degradation and measuring soil organisms.

The term commonly used by farmers to indicate soil fertility decline was "soil weakness". When soils become "weak", yields decline. The researcher used various indicators to assess the fertility of a field, such as yield, soil colour, compactness and the composition of the vegetation. After a period of continuous cropping all these indicators changed. The colour transforms from dark red to brown, the odour disappears, and the flora also changed.

Yield – If a soil is alive and fertile, then crop yields are high. Farmers mainly assess yields in terms of crop performance and less on the amount of crop harvested per unit area of land. For example, the thickness of the ear of maize, the number of tomato fruits and the thickness of cassava roots are indicators of soil fertility. The crops' performance indicated which parts of the plot were weakening.

Colour of the soil – Colour indicated the presence of organic material and varied between different parts of the field. After a fallow a soil was fertile, having a dark red colour. This showed that the soil had more humus. After a certain period of cropping, the soil colour turned brown, indicating a decrease in soil fertility.

Compactness of the soil – A fertile soil is rather soft and easy to work. When fertility declined the soil became hard and more compact. *Striga* weed had a similar effect on soils.

Flora of the soil – The composition and performance of weeds and trees indicated the level of soil fertility. Most of the older farmers knew which species indicated a higher soil fertility in the Moiben area such as black night shade (*Solanum nigram*), pigweed (*Amaranthus hybridus*), thorn apple (*Datura stramonium*). Some plant species indicating poor soils were tick berry (*Lantana camara*), poverty grass (*Harpachne schimperi*), fleabane (*Conynza banariensis*) and black jack (*Bidens pilosa*).

Soil pH- The researcher used soil samples from areas practicing mechanized agriculture and one that does not as a control experiment. Using a litmus paper, the researcher used a small sample of the soils and mixed them with distilled water, into which a strip of litmus paper was inserted. The soils where farmers practiced mechanized agriculture turned the blue litmus paper red indicating acidic conditions as a result of excessive fertilizer use. The soils in areas which do not practice mechanized agriculture seemed neutral as the blue litmus paper did not change.

Determining physical degradation- The researcher took some small soil clods of about 1 cm diameter from a ploughed field and from an unploughed area nearby. The researcher looked at both soil samples and it was generally easy to see the darker soil colour of the un-ploughed sample (higher organic matter content). The researcher dropped those clods carefully into a bowl of water and observed how the ploughed soil disintegrated while the unploughed soil stayed intact. This revealed that ploughed lands had lost their structure and were loose.

Measuring soil organisms- The researcher dug up some soil with a spade in a ploughed field and in an unploughed area and looked at the difference in number and diversity of fauna species. Generally there were more organisms and more crumbs (aggregates) in the unploughed field. This revealed that the mechanized lands had undergone biological degradation due to limited number of soil fauna.

Soil compaction had (11%). It was reported by farmers that regular use of disc ploughs reduce soil aggregates to small particles and produced a compacted layer or plough pan which prevents air, water or roots from penetrating the subs oil.

Vegetation removal (09%) was as a result of ploughing and farming methods that do not protect the environment induced the destruction of trees and shrubs on vast lands. The farm areas were nude in dry season and at the beginning of the rainy season. The overgrazing due to the important number of cattle near watering points reduced the regeneration vegetation capacities.

Water logging (07%), was prevalent especially after heavy storms. Pools of stagnant water were observed in gardens. This was attributed to lack of vegetation cover on soils, the soils were sealed by heavy machines and development of hard pans thus could not allow infiltration. To determine water logging, the researcher scooped a soil sample from the water logged areas and put it a polythene bag to measure its filtration rate in terms of time and speed. It was found out that the soils took so long to allow water percolation through them, also the speed at which water was flowing through the soil was very slow indicating poor soil structure and too much clay content in the lands.

Plate 8: water logging in a field of maize

(Source: field 2011)

Loss of biodiversity (04%) was because the soils were prepared quickly with little care. Most of the soil useful soil organisms such as earthworms were brought to the surface of the soil and were exposed to the predators and the sun's intensive heat. The activity of the soil fauna including worms and termites was almost null because of the lack of organic matter on the farm areas. The use of pesticides and herbicides also contributed to the disappearance of some insect soil organisms because they were poisoned.

Others had (02%) which included loss of organic matter which was the least represented. This was because the farmers were not aware of it and could not identify it directly as the other effects of mechanized agriculture.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Conclusions

Results from the field indicated that agricultural practices that increase production and labour productivity were being adopted by farmers in large measure for example fertilizer application, use of pesticides and herbicide application. Practices that were designed to limit damage to the environment were adopted more selectively and slowly, or were ignored completely like crop rotation.

The study revealed that there was a large number of respondents that practiced mechanized agriculture while there were few farmers who practiced non-mechanized agriculture in the area of study. The mechanized farmers possessed equipment such as tractors, planters, combined harvesters and ploughs and the non mechanized farmers possessed simple hand tools such as hoes among others.

According to the study findings the farmers were culturally reported to lead an agricultural kind of life in order to produce so much agricultural products, whereby a farmer's economic power/financial ability was measured in terms of how much machinery and yields he/she obtained by the technology employed.

Soils dedicated to arable crop land and pasture land with the associated strong decrease of vegetated area had increased. A more detailed analysis through overview of previous farm records and transect walk in the farms revealed that an important trend had been the conversion of traditional cultivations like millet and sorghum to new export crops like wheat and maize.

It had been verified that erosion constituted one of the most serious and generalized forms of soil degradation in the region. This had increased during past decades by the uncontrolled expansion of mechanized agriculture in non-suitable zones and the extension of agriculture on slopes susceptible to erosion, which in certain areas had forced extensive areas of land to be abandoned. The principal problems of soil degradation that affected the region included: water and wind erosion, salinization, drainage problems, loss of fertility, acidification, soil compaction, loss of soil structure, biological degradation and irreversible changes in soil use and pollution.

The impacts that caused soil modifications were by anthropogenic interventions which had been magnified with increasing mechanization, agrochemicals application, in particular by synthetic fertilizers, pesticides, herbicides and fungicides. However there were other causes of soil degradation other than mechanized agriculture which included climate and natural hazards.

Farmers were aware that soil degradation, in various forms, was taking place on their cultivated agricultural land. This was based on their perception and interpretation of indicators such as weed infestation, reduced soil fertility and soil compaction. Continuous cropping and mono-cropping were the main reasons of soil degradation indicated by farmers.

5.1 Recommendations

There is need for more concerted efforts on soil monitoring studies in the area .This calls for team research work in the area involving research scientists from research institutes, universities and conservation agencies. Also, any plan to reduce further pressures of farming on soil must include programmes such as poverty alleviation as well as inculcation of good farming methods that will make farmers less dependent on extensive farming practices. Integrated farming systems should be adopted whereby farming practices are incorporated together with tree planting.

Indigenous Knowledge should be encouraged particularly for subsistent farmers who can not afford inputs for modern agriculture. Other practices should be adapted to local conditions such as the use of maize stalks and other crop residues to improve soil fertility, as opposed to adoption of fertilizers. Mechanized agriculture should complement rather than compete with indigenous agriculture.

The Government of Kenya should rehabilitate the Agricultural Mechanisation Services (AMS) stations, which can assist in giving farmers technical services at appropriate times to enable them use the right equipment and inputs in their fields.

Integrated soil fertility management. Integrated soil fertility management combines a mix of organic and inorganic materials, used with close attention to timing and placing of the inputs to maximise nutrient use efficiency. It provides an approach, which needs to be tailored to the characteristics of the site, and constraints faced by the farmer. This approach demands an emphasis on context-specific, adaptive responses based on a new partnership between researchers, farmers and extension workers. Such skills can be strengthened by farmer field schools, farmer led events such as green fairs, seed fairs, training activities, and action-research approaches which involve, for example, joint elaboration and analysis of resource flow maps. Choice of intervention strategy will be determined by context.

Adoption of organic agriculture. Organic agriculture is a production system that sustains the health of soils, ecosystems and people. Organic farming is the form of agriculture that relies on crop rotation, green manure, compost, biological pest control and mechanical cultivation to maintain soil productivity and control pests, excluding or strictly limiting use of synthetic fertilizers and synthetic pesticides, plant growth regulators, livestock feed additives and genetically modified organisms. It depends on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

Soil conservation measures. Certain conservation measures can reduce soil degradation. Soil/land management practices such as tillage and cropping practices, directly affect the overall soil on a farm. When crop rotations or changing tillage practices are not enough to control degradation on a field, a combination of measures might be necessary. For example, contour ploughing, strip cropping, or terracing may be considered.

Types of conservation measures include:

- Agronomic: such as plant/soil cover, conservation farming methods, contour farming.
- Vegetative: such as planting barriers (vegetative strips), live fences, windbreaks.
- Structural: such as Fanya Juus, terraces, bunds, cut off drains, barriers.

Education and training: Training is necessary and paramount, not only for farming skills but also for management of farm machinery and other technologies. Credible training schemes are necessary. The farmers need to be regularly updated and this can be achieved by Farmer Field Schools, ministry of agriculture and environment, and extension officers.

The technology that farmers require needs to be locally sourced and adapted to local conditions in a continuous process of research, adaptation, extension, monitoring and evaluation. Certification of machinery is also needed in order to give relevant information to farmers and extension services on the actual performance of machinery in local conditions of use. For example tractor test should be examined and adequately adapted for Africa's local conditions. Impartial testing for the whole range of nationally-manufactured farm equipment will be needed to support manufacturers in producing good quality products. Manual and animal power systems will need to be included in all aspects.

Governments and NEMA also have a role in maintaining soil quality standards. Standards may also be laid down in regulating the amount of fertilizers applied in the soil, soil pollution and use of the soil.

Further research is needed to quantitatively evaluate the mechanisms enhancing soil recovery on abandoned and degraded agricultural land.

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APPENDICES

Appendix I-TIME SCHEDULE

	JUNE	JULY	AUGUST	SEPTEMBER
Instruments design	xx			
Piloting		Xx		
Soil sampling & planting	xx			
Data collection		Xx		
Data analysis and interpretation			xx	
Writing draft of the dissertation			xx	
Writing of the corrected dissertation, binding and submission				xx

APPENDIX II - PROPOSED BUDGET

Item	Cost (KShs)
Stationary	1,800
Communication	2,400
Transport	6,000
Typesetting, printing & binding the report	2,000
Research assistants	10,000
Tools, equipment and materials	20,000
Meals	6,000
Miscellaneous	20,000
TOTAL	**110,400**

APPENDIX III- Instruments

a). QUESTIONNAIRE FOR FARMERS.

I am a student of Kampala International University pursuing Bachelor of Science in Environmental Management.

First, I would like to thank you in advance for taking the time to complete this questionnaire. The purpose of this questionnaire is to aid me research in my project entitled **"Mechanized agriculture and land degradation: A case study of Moiben division, Uasin Gishu district – Kenya."** as the title of my research proposal.

The driving force behind this research a part from the degree that I am studying is to shed light for scholars to understand soil degradation. Rest assured all information submitted will remain anonymous, to be used purely for the purpose of this proposal.

Instructions

√ Please kindly responds to all items in these questionnaires.

√ Put **(a Tick)** alongside the option that is most applicable to you or fill in the spaces provided.

√ You do not need to write your name in this questionnaire.

SECTION A: RESPONDENTS BACKGROUND INFORMATION.

1. What is your age? Below 30yrs [ ] 30-40yrs [ ] Above 40yrs [ ]

2. Which of these describes your sex? Male [ ] Female [ ]

3. Marital status Single [ ] Married [ ] Divorced [ ] Widowed [ ]

4. How many children do you have? None [ ] 1-2 [ ] 3-5 [ ] Above 5 [ ]

5. Which one of these education levels most applies to you?

   Secondary certificate [ ] Diploma [ ] Bachelor's Degree [ ]

   Masters [ ] Doctorate degree [ ]

   Any other specify.......................................

6. What is your working experience? Below 5yrs [ ] 5-10 yrs [Above 10yrs [ ]

7. Which department do you work in?

....

8. For how long have you lived in this place?

Less than one year [ ] 1-5 years [ ]

6-10 years [ ] More than 10 years [ ]

9. What is your religious affiliation?

Catholic [ ] Anglican [ ] Pentecost [ ]

Islam [ ] SDA [ ] Other (specify)....................

SECTION B: AGRICULTURAL MECHANISATION TECHNOLOGIES AND EQUIPMENT

10. Mechanization technology

(i) What kind of mechanization technology do you use?

Tractor [ ] Hand tools [ ] Animal traction [ ]

(ii) How often do you use it?

Daily [ ] 2-3 days [ ] Weekly [ ] More than a week [ ]

(iii) Are they accessible to all farmers?

Yes [ ] No [ ]

If no, give reasons

No farmers' trainee [ ] Few farmers [ ]

Insufficient [ ] Other(specify)..

(iv) Give your comments on the general adoption of the mechanization technology you use

....

....

(v) How many acres are ploughed per day using the mechanization technology chosen?

Less than one [ ] 6-10 [ ]

2-5 [ ] Above 10 [ ]

12. Equipment

(i) What kind of equipment are available in your community?

Garden equipment [ ] Protective equipment [ ]

Livestock equipment [ ] Others (specify) ....

(ii) From your answer in above (12 i) give examples

....

....

....

(iii) When do you use it?

Cultivation [ ] Weeding [ ] Animal management [ ]

Harvesting [ ] Livestock treatment [ ] Other (specify) ....

SECTION C: ACTIVITIES INVOLVED IN MECHANISED AGRICULTURE

13. (i)Your livelihood depends mainly depends on:

Cropping only [ ] Both cropping and livestock [ ] Livestock only [ ]

(ii) If you have livestock indicate type and number

Type	no.	Use	zero grazing (yes or no)
....	....	....	....
....	....	....	....

(iii) If you grow crops, what are the major crops grown in on your farm in order of importance?

....

....

(iv) Indicate the use of the crops

....

....

(v) Do you grow these crops alone or do you mix them with other crops?

Alone [ ] With other crops (name the most combinations)..........................

(vi) Do you plant the same crop every year or change to other crops or practice fallowing?

Plant the same crop each year [ ] Change to other crops [ ]

Change to other crops and then practice fallowing [ ]

(vii)What do you do with your crop residue?

Burn them [ ] Use them as feed [ ]

Use them for cooking [ ] Others (specify)..................................

(viii)What kind of activities of mechanization do you involve in?

Planting [ ] ploughing [ ] processing [ ] transportation [ ]

Weeding [ ] irrigation [ ] Harvesting [ ] Animal spraying [ ]

Fertilizer application [ ] Land clearing [ ] Others (specify) ....

(ix)Mention the most frequent activity

....

(x) Explain how it is done

....
....
....

(xi)What season do you do it?

....

(xii)Is the activity aimed at conserving the soil?

Yes [ ] No [ ]

(xiii)If yes, how does it conserve the soil in your area?

....
....

SECTION D: EFFECTS OF MECHANISED AGRICULTURE

14.(i)What do you think about the impacts of mechanization on soil?

Is it positive, why?

....
....

Is it negative, why?

....
....

(ii)Do the farmers do mechanization effectively and protect the soil? Explain briefly

....
....

(iii)What effects does mechanization pose on soil?

Pollution [ ] soil erosion [ ] compaction of soil [ ]

Loss of soil fertility [ ] loss of biodiversity [ ] Others (specify) ....

(iv)Do you observe any signs of soil degradation?

....

(v)If yes what features lead you to believe that such a problem exists?

....
....

(vi)Do you think soil degradation affects this area alone? Explain briefly

....
....

(viii)For how long has soil degradation been a problem in this place?

....
....

(ix)What would be the possible strategies to change the situation?

....
....

Thank you for your contribution

b). INTERVIEW GUIDE FOR EXTENSION OFFICERS

I am a student of Kampala International University pursuing Bachelor of Science in Environmental Management.

First, I would like to thank you in advance for taking the time to complete this questionnaire. The purpose of this questionnaire is to aid me research into **"Mechanized agriculture and soil degradation: A case study of Soy division, Uasin Gishu district – Kenya"** as the title of my research proposal.

The driving force behind this research a part from the degree that I am studying is to shed light for scholars to understand soil degradation. Rest assured all information submitted will remain anonymous, to be used purely for the purpose of this proposal.

Instructions

√ **Please** kindly respond to all items in these questionnaires

√ Put (a Tick) alongside the option that is most applicable to you or fill in the spaces provided

√ Do not need to write your name in this questionnaire.

SECTION A: BACKGROUND INFORMATION.

Please tick

1. What is your age? Below 30yrs [ ] 30-40yrs [ ] Above 40yrs [ ]
2. Which of these best describes your sex? Male [ ] Female [ ]
3. Marital status Single [ ] Married [ ] Divorced [ ] Widowed [ ]
4. How many children do you have? None [ ] 1-2 [ ] 3-5 [ ] Above 5 [ ]
5. Which of these levels of education best applies to you?

   Secondary certificate [ ] Diploma [ ] Bachelor's Degree [ ]

   Masters [ ] Doctorate degree [ ] Any other specify..........................
6. What is working experience? Below 5yrs [ ] 5-10 yrs [ ] Above 10yrs [ ]
7. Which department do you work in? ....
8. For how long have you lived in this place?

   Less than one year [ ] 1-5 years [ ]

6-10 years [ ] More than 10 years [ ]

9. What is your religious affiliation?

Catholic [ ] Anglican [ ] Islam [ ]

SDA [ ] Pentecost [ ] Other (specify) ……………………

10. What do you understand by the terms

Mechanized agriculture?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

Soil degradation?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

11. Why mechanize agriculture?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

12. What is the state of mechanization currently?

Very high [ ] Moderate [ ] Very low [ ]

13. What kind of mechanization technology is available in this area?

Animal traction [ ] Hand tools [ ] Tractor [ ]

14. Which equipment are commonly used? Name and explain their use

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

15. What is the relationship between mechanization and soil degradation?

Positive [ ] Negative [ ] No relationship [ ]

Explain

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

16. Give your opinion on soil degradation

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

17. (i) Do the agricultural officers, extension officers environmentalists come and inspect the soils frequently?

Yes [ ]   No [ ]

(ii) What do they do when they make such visits?

....
....
....

18. Are the farmers involved in community service of conserving the soils once in a while?

If yes, then how?

....
....

If no, why?

....
....

19. (i) What activities do farmers perform in mechanized agriculture?

....
....
....

(ii)Which of the activities impacts most negatively on soils? State and explain

....
....
....

20. Do you observe any signs of soil degradation? If yes what could you think what is the cause?

....
....
....

21. How has mechanization affected the soils?

....
....
....

22. What was the condition of the soils before introduction of mechanized agriculture?

....
....
....

23. Suggest strategies for trying to minimize these problems

....
....
....

24. Which body is responsible for monitoring mechanization and soil degradation?

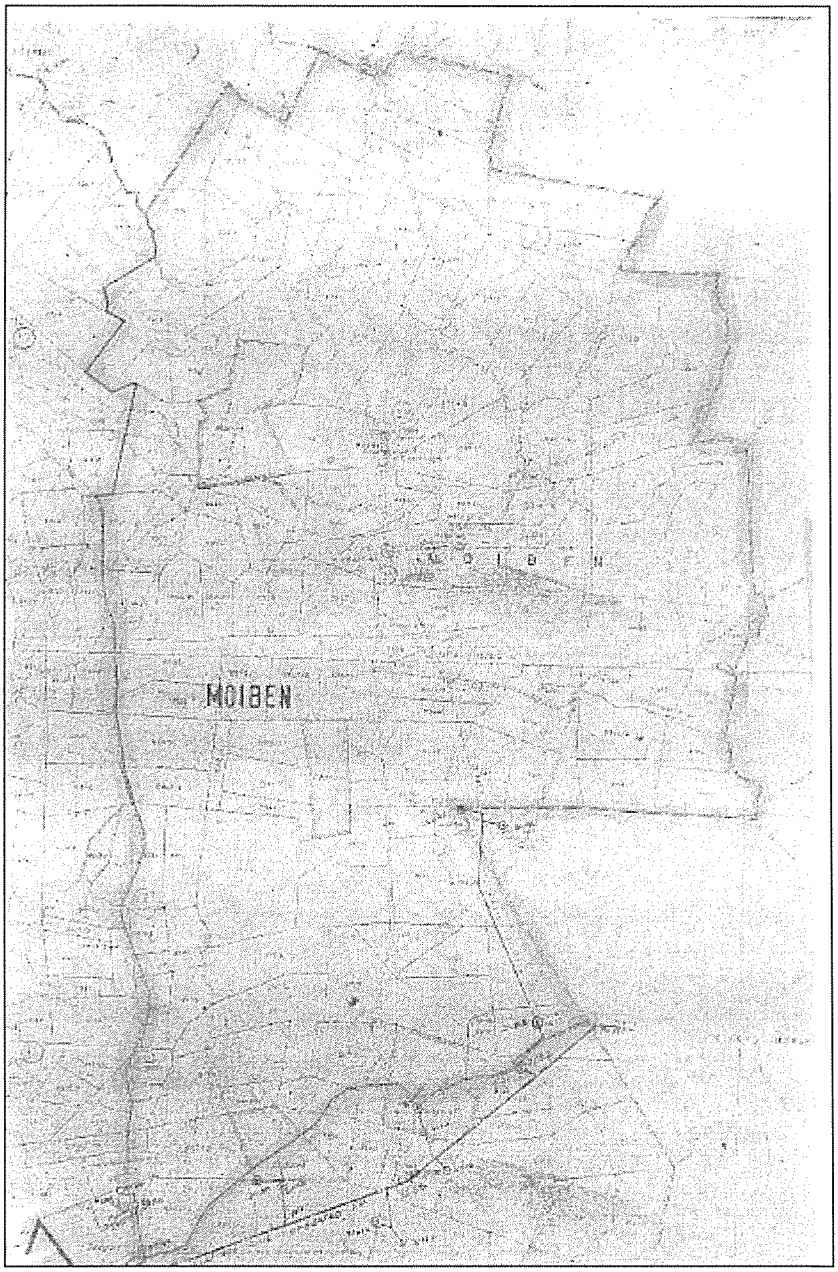
....
....

25. Do you receive assistance from any organization to tackle this problem of soil degradation? Yes [ ] no [ ]

Please specify the organization if any and how it assists
....
....

I am so greatful for the time and information you have given me.

APPENDIX IV-Map of Moiben Division



Source: Kenya Power and Lighting Company drawing office Eldoret

APPENDIX IV- Map of Kenya showing Uasin Gishu district

Source: Google maps