THE CAUSES AND EFFECTS OF SOIL DEGRADATION: A CASE STUDY OF KOMBEWA DIVISION, KISUMU DISTRICT, KENYA

BY

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A RESEARCH REPORT SUBMITTED TO THE FACULTY OF ENGINEERING AND APPLIED SCIENCES AS PART OF THE REQUIREMENTS FOR THE AWARD OF A BACHELOR OF SCIENCE DEGREE IN ENVIRONMENTAL MANAGEMENT OF KAMPALA INTERNATIONAL UNIVERSITY

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DECLARATION

Enonda Edgar Ochieng, declare that this research report on the causes and effects of soil egradation in Kombewa division of Kisumu district is my original work and has never been ıbmitted to any university for any award.

/here the works of others have been cited, acknowledgements have been made.

gnature..... Date..1ST SEPTEMBER 2011...

NONDA EDGAR OCHIENG'.

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..... Date.....

DR. ALI B. TWAHA.

DEDICATION

To my dear wife, Lince and our son, Ivan

ACKNOWLEDGEMENTS

First and foremost, I give my special thanks to God for taking me this far. Secondly, I would like to thank my dear parents Gilbert and Zirah Ochieng, my siblings Sue, Frank, Aaron, Sospeter and Alpha and my dear wife Lince for their encouragement and support throughout the study.

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I also convey my sincere gratitude to the Ministry of Agriculture, Kisumu district office for the vital information that helped a lot during the study period. I also thank the communities in Kombewa division and most especially those in Seme west location for participating in the research project.

May God bless you all.

Thank You.

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LIST OF ACRONYMS

CAP	-	Community Action Plan
D.A.P	-	Di-ammonium Phosphate
FAO	-	Food Agricultural Organization
FYM	-	Farm Yard Manure
IK	-	Indigenous Knowledge
MOA	-	Ministry Of Agriculture
SWC	-	Soil and Water Conservation
UN	-	United Nations
UNEP	-	United Nations Environmental Program
WRI	-	World Resource Institute

CHAPTER ONE

INTRODUCTION

Background

Soil degradation is recognized worldwide as a major environmental issue which leads to a significant reduction of the productive capacity of land (UNEP, 1994). Human activities contributing to land degradation include unsustainable agricultural land use, poor soil and water management practices, deforestation, removal of natural vegetation, frequent use of heavy machinery, overgrazing, improper crop rotation and poor irrigation practices. Natural disasters such as drought, floods and landslides also contribute to this problem.

In the early 1990s, about 910 million ha of land were classified as moderately degraded with greatly reduced agricultural productivity. A total of 305 million ha of soils ranged between strongly degraded and extremely degraded. The majority of extremely degraded soils were found in Africa (UNEP, 1994).

In Africa, where large populations are dependent on natural resources for their livelihood, and subsistence agriculture and pastoralism form the backbone of the economy, the direct and most severe impact of soil degradation is food insecurity that may ultimately result in famine. The only alternative for survival of local communities is often to expand agriculture and grazing areas onto marginal land and wilderness areas-a process that often degrades forests, woodlands and grasslands, fragments natural ecosystems and reduces biodiversity. Unsustainable use of

these resources can lead to accelerated erosion and physical and chemical deterioration of soils beyond limits of possible restoration of their productive capacity.

The root causes of soil degradation are highly complex as well as site specific, but the driving forces often involve adverse climatic conditions in combination with social, political, economic and cultural factors that strain marginal lands beyond ecologically sustainable limits.

Soil degradation in Kenya like in many developing countries is caused by peoples' interaction with the basic natural resource, land. Land use, therefore is a major player in the occurrence and acceleration of land degradation in Kenya. Approximately 90% of Kenya's population derives its livelihood from land in the form of agriculture; hence agricultural activities together with the recent proliferation of the industrial sector are thought to contribute greatly to land degradation and the consequent soil degradation.

The major soil degradation problems in Kenya include;

- Loss of soil fertility
- Erosion
- Salinity
- Soil compaction
- Soil acidification and
- Build up of dangerous chemicals

Problem statement,

Kombewa division is a smaller administrative unit of the district and according to the agricultural office in the region, it is the leading division with severe soil degradation. The area is dominated

with sandy soils, although there are some areas, especially near streams ,that have favorable clay loam soils. The communities here are dependent on their farms for food and practice subsistence farming, although on good harvests, they sell the surplus products. Crops commonly grown include maize, sesame, groundnuts and cassava.

Over the years, the production potential of this area has been declining due to poor farming practices. This has led to massive soil degradation. According to the district agricultural office, nothing substantial has been carried out to ease the plight of the communities. The population therefore continues with their unsustainable farming practices oblivious of the consequences.

OBJECTIVES

Overall objective

The overall objective of this study was to find out the causes and effects of soil degradation in Kombewa division of Kisumu district in Kenya.

Specific objectives

The specific objectives of the study were:

- To identify the causes of soil degradation in Kombewa division,
- To asses the effects of soil degradation on the communities in Kombewa division,
- To develop systems to promote soil and water conservation in the division,

Research questions

This study was guided by the following research questions

- Was soil degradation the driving force behind decreased food production in Kombewa division?
- Are peoples' livelihoods being affected by the current soil conditions in the area?
- Was the community willing to adopt good farming practices to improve their farm productivity?
- Was the community aware of their detrimental farming practices or are they oblivious?
- Were the societal perceptions on land and the values they place on land a cause of soil degradation?

Limitations of the study

Due to the nature of the study, the time allocated and the funds available, the study did not involve complex soil science techniques but based its findings from the information obtained from the interviewees and observations made from the field.

CHAPTER TWO

LITERATURE REVIEW

Soil degradation

Soil degradation is a form of land degradation, a concept in which the value of the biophysical environment is affected by one or more combination of human-induced processes acting upon the land .Natural hazards are excluded as a cause; however human activities can indirectly affect phenomena such as floods and bushfires. Connelly (1994) suggests that land use does not always intensify overtime but can dis-intensify too. The expansion or intensification of human land use calls for more soil conservation methods (Tiffen et al., 1994).

Causes of soil degradation

The most prevalent causes of soil degradation in East Africa and indeed in the world is nutrient depletion and erosion (Larson 1983).According to Zinck (1986), the degree of influence varies from place to place with one or more factors being responsible for the type of soil occurring in each place.

Nutrient depletion

Nutrient depletion as a form of land degradation has severe economic impact at the global scale, specially in sub-Saharan Africa. Stoorvogel *et al.* (1993) have estimated nutrient balances for 8 countries in sub-Saharan Africa. Annual depletion rates of soil fertility were estimated at 22 kg N, 3 kg P, and 15 kg K ha-1. In Zimbabwe, soil erosion is responsible for an annual loss of N

and P alone totaling US$1.5 billion. In South Asia, the annual economic loss is estimated at US$600 million for nutrient loss by erosion, and US$1,200 million due to soil fertility depletion (UNEP, 1994).

Jager et al. (2001) reveal that one year nutrient depletion measurement from different sites in Kenya revealed that full nutrient balances at farm level were negative for nitrogen. The phosphorus balance varied from neutral to positive. A study in Embu Kenya revealed that considerable amounts of mineral nutrients are applied to high earning cash crops e.g. tea, coffee and Napier grass as these crops give the best economic returns for money spent on fertilizers and as a result nutrients are neutral to positive. Very few inputs are applied to fields of staple crops such as maize and beans where the negative nutrient balance results in declining soil fertility. Another contributing factor to fertility decline is the removal of crop residues from the fields (Gichuru, 1994). Soils are rapidly losing the ability to supply nutrients in the amounts, forms and proportions required for maximum plant growth and according to Tenywa et al. (1999), the following reasons apply:

- Very low use of organic and inorganic fertilizers.
- Plant nutrients are removed through harvested crops, erosion, leaching, volatilization and burning of crops residues. Efforts to replenish the nutrients are very minimal.
- Poor conservation and management of rain water.
- Growing of trees is not focused on the improvement of soil fertility (many farmers are not familiar with modern agro-forestry practices)

Soil erosion

Soil erosion is one cause of soil degradation, together with soil compaction, low organic matter and loss of soil structure, poor internal drainage, salinization, and soil acidity problems. These other forms of soil degradation, serious in themselves, usually contribute to accelerated soil erosion. Soil erosion is a naturally occurring process on all land. The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year (Shelton, 2003)

Soil erosion is a common phenomenon in the study area and this is linked to continuous cultivation without appropriate soil management practices like terracing, contour farming and thrashes lines. Expansion of livestock farming practices has led to soil erosion. These practices tend to remove vegetation cover, thus leaving the land bare subjecting it to severe sheet and gully erosion.

Overgrazing

Overgrazing is the grazing of natural pastures at stocking intensities above the livestock carrying capacity; the resulting decrease in the vegetation cover is a leading cause of wind and water erosion (Scherr, 1999). According to Science Daily (2009), the intense grazing pressure exerted by cattle, which eat mainly grassy and herbaceous plants, means that the unpalatable species that the livestock leave alone no longer have any competition and eventually take over the whole of the space. This overgrazing therefore causes the grassland ecosystem to be replaced by thorn scrub and pine, less effective for holding in place the fine layer of fertile soil. ISRIC (2000), found out that 36% of soils degraded by overgrazing are in Africa. Overgrazing is the main cause of soil degradation in Africa (50%), in the South Pacific and in Australia (80%). By threatening

the productive capacity and/or reproduction of vegetation, overgrazing strips soils, thus making them more vulnerable to hydraulic erosion (this is the case for 56% of soil degradation) and wind erosion (28% of cases).

Poor agricultural practices

Agricultural activities that can cause soil degradation include shifting cultivation without adequate fallow periods, absence of soil conservation measures, cultivation of fragile or marginal lands, unbalanced fertilizer use, and a host of possible problems arising from faulty planning or management of irrigation. Agriculture plays a large part in soil degradation, especially clearing, irrigation, the spreading of chemical fertilisers and pesticides, overgrazing and even the passage of heavy farming equipment.

The clearing and deforestation of large plots of land to increase the agricultural surface area change humus composition and soil formation. This is because of varied primitive vegetation being replaced by secondary vegetation (monoculture being the extreme).

Tillage destroys superior layers of soil as well as the layer of humus and can even cause a plough sole/ hardpan (lower layer of compact land) to form because of ploughs regularly passing through soil at the same depth. Farming equipment also contributes to soil compaction especially when it weighs more than 5 tons.

Irrigation and soil drainage can cause soil acidification and salination whilst the use of chemical fertilisers and pesticides contributes to reducing soil capillarity (runoff) as well as its consistency. Irrigation in the Aral basin caused the salination and flooding of soils (this can be

attributed to canals not being covered and bad drainage). It also famously caused the Aral Sea to dry out. Using pesticides and chemical fertilisers destroys soil fauna which is necessary for aerating soil (Brown, 2001).

Population pressure

Population factors in soil degradation processes occur in the context of the underlying causes. It is indeed one of the two major basic causes of soil degradation along with land shortage. Land shortage is a consequence of continued population growth in the face of the finiteness of land resources. In the context of land shortage, the growing population pressure during 1980-1990, has led to decreases in the already small areas of agricultural land per person

Population pressure also operates through other mechanisms. Improper agricultural practices, for instance, occur only under constraints such as the saturation of good lands under population pressure which leads settlers to cultivate too shallow or too steep soils, plough fallow land before it has recovered its fertility, or attempt to obtain multiple crops by irrigating unsuitable soils (Ian, 2007).

Effects of soil degradation

The underlying effect of soil infertility is decreased farm production as a result of decreased soil nutrients that might have been washed by erosion. Erosion clears the overall base for agriculture. In turn, the loss of crop lands encourages farmers to overuse the remaining land and move to forests, grasslands and rangelands including other fragile and other environmentally sensitive areas. The most important factors which explain loss of yield potential when erosion occurs are loss of organic matter, depletion of nutrients and reduced plant available. Lal (1985) reported

that organic matter element loss due to erosion may be one of the major causes of fertility depletion of tropical soils.

On-Site Effects

The implications of soil erosion extend beyond the removal of valuable topsoil. Crop emergence, growth and yield are directly affected through the loss of natural nutrients and applied fertilizers with the soil. Seeds and plants can be disturbed or completely removed from the eroded site. Organic matter from the soil, residues and any applied manure is relatively light-weight and can be readily transported off the field, particularly during spring thaw conditions. Pesticides may also be carried off the site with the eroded soil.

Soil quality, structure, stability and texture can be affected by the loss of soil. The breakdown of aggregates and the removal of smaller particles or entire layers of soil or organic matter can weaken the structure and even change the texture. Textural changes can in turn affect the water-holding capacity of the soil, making it more susceptible to extreme condition such a drought Shelton, 2003).The main on-site effect of land degradation is a decline in yields and the increased need for inputs to maintain those yields: Since "sub soils generally contain fewer nutrients than top soils, more fertilizer is needed to maintain crop yields. This, in turn, increases production costs. Moreover, the addition of fertilizer alone cannot compensate for all the nutrients lost when topsoil erodes" (FAO, 1983). Where degradation is serious, the plots may be either abandoned temporarily or permanently, or converted to inferior value uses, e.g. cropland being converted to grazing land, or grazing land left to shrubs.

Off-Site Effects

Off-site impacts of soil erosion are not always as apparent as the on-site effects. Eroded soil, deposited down slope can inhibit or delay the emergence of seeds, bury small seedling and necessitate replanting in the affected areas. Sediment can be deposited on down slope properties and can contribute to road damage.

Sediment which reaches streams or watercourses can accelerate ban erosion, clog drainage ditches and stream channels, silt in reservoirs, cover fish spawning grounds and reduce downstream water quality. Pesticides and fertilizers, frequently transported along with the eroding soil can contaminate or pollute downstream water sources and recreational areas.

Lack, (1999) argue that soil loss can reduce potential soil productivity for many agricultural crops hus declining agricultural productivity resulting from soil erosion will lead to scarcity of food nd if such trend is left unchecked it could threaten food production in many parts of the ountry. It has been argued that measurements of soil erosion from test plots "typically verestimate the consequences for productivity, since the eroded soil can remain for decades lsewhere in the farming landscape before it is delivered to the oceans. Thus, a portion of on-site rosion represents a transfer of assets rather than a complete loss from the standpoint of gricultural productivity" (WRI, 1993). This argument should not be carried too far. First, as the ame source adds, geographic shifts in productivity have potentially important distributional onsequences: it is not unimportant that topsoil washed from slopes held by the poor ends up in alley bottoms held by the better-off, or is lost by a mountainous country to the benefit of ownstream countries. Also, the fine soil particles for the most part are carried to waterways and eas; along the way they may make water unsuitable for human consumption, silt up dams,

irrigation systems or river transport channels. Eventually their nutrients are permanently lost for agriculture, but cause nutrient loading and eutrophication, damaging aquatic life systems and fisheries.

CHAPTER THREE

MATERIAL AND METHODS

Description of the study area

Kisumu district covers a land area of approximately 769 square kilometer and 492 square kilometer of the water surface of Lake Victoria. To the west, the district borders Siaya district, Vihiga district to the north, Nyando to the east.

The district occupies part of the Winam gulf, a portion of Lake Victoria and the area of which is Kisumu town. Topographically, the district is divided into two zones-Kano plains and midland areas of Maseno and Kombewa. Major streams include Kibos, Awach, and Magadi.

The district receives an annual rainfall between 560mm to 1630mm.This falls during rainy season with long rains coming in between March and July while the short rains come between September and October. The temperature ranges between 20 to 38 degrees centigrade.

Kombewa division is located about 30 km west of Kisumu with an estimated population 60,183 people (1999 census).It has an altitude of 1131m and experiences tropical humid climate. The area receives an average of 1000mm of rainfall annually with two rain seasons in a year. The temperatures fall between 20 to 30 degrees centigrade. The areas is located on latitude 0-15'0N and longitude 34 55'0 E.

The people of this area mainly practice subsistence agriculture with a small population, mainly those leaving along the shores of lake Victoria practicing fishing.

Land preparation is mainly done by hand hoes and ox driven ploughs during the onset of rains. There are two planting seasons in this area which are relative to the rainy season. The long rains come between the months of March and July while the short rains appear between September

and October. The crops grown are mainly food crops and include groundnuts, cassava, and some little cereals of maize and sesame.

The larger part of the study area is dominated with sandy soils.

DATA COLLECTION METHODS

Questionnaires

A questionnaire covering the objectives of the study was designed. A number of questions were given to a cross section of respondents. Both open-ended and closed-ended questions were used to facilitate information gathering.

Observations

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 stunted growth of crops, and farming practices were made. The nature of degradation was identified through typical soil degradation indicators such as soil erosion.

Interviews

In order to get more detailed information, a sample from the study area was interviewed. Structured interviews were used to collect data from farmers who were illiterate. This allowed face to face interaction in soliciting pertinent information from the respondent.

Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal and Community Action Planning (CAP) which is a mixture of open participatory tools or semi-structured tools were used. This approach was utilized because it provides excellent opportunities for the community members to share their views and opinions easily. Both involve a good array of tools for involving people in the community by using discussions and observations.

Data analysis

Data was analyzed both qualitatively and quantitatively based on the objectives of the study. The data was analyzed using Ms Excel to facilitate interpretation.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

Background information

After successfully administering the questionnaires to the planned 60 respondents, 48 of them responded while 12 did not respond. However, this was adequate proportion of the sample size.

Table 1: The response rate

Cadre of Respondents	Planned Responses	Actual Responses	Non-Responses
Field extension officers	3	2	1
Local farmers	57	46	11
Total	**60**	**48**	**12**

The results showed that not all the intended respondents were positive although the ones who responded were 80% which was adequate proportion of the sample size. The non-response was as result of some farmers not literate enough to interpret the questions and the inadequacy of reliable interpreters. There was also accessibility problems as some of the targeted respondents were never reached as scheduled.

Table 2: Age distribution

Age (Years)	Respondents	Percentage
Below 30	2	4
Between 31-39	5	10
Between 40-49	8	17
Over 50	33	69
Total	**48**	**100**

2 (4%) of the farmers who responded were below 30 years, 5 (10%) were between 31-39 years, 3 (17%) were between 40-49 years while the majority of the farmers 33, were 50 years and ıbove representing 69% (Table 2).

The farmers with more than 50 years were very essential in this study because their information gave comprehensive trend lines of the farm performance over the years. A brief history of the ırea was very important as it provided enough evidence of the past and present soil conditions. The older members of the community were also very important as they gave out some of the ndigenous Knowledge (IK) that has been used by the community in to deal with issues related to oil management. As later discussed, they gave various systems applied in assessing soil fertility nd other related aspects.

4.2 Introduction to farming activities in the study area.

The study, through personal observation, revealed that both livestock and crop farming are the communities' core activity and are carried out on subsistence basis although some find their way into the market but on very rare occasions where surplus production are realized especially on vegetable products. According to Atieno and Cohen, (1989), the Luo people immigrated from the Sudan during the 1500s and operated an agro-pastoral system producing mainly milk, butter, blood and occasionally meat. Shifting cultivation dominated and was subsistence oriented. The main crops grown were finger millet (*Elusine coracana*), sorghurm (*Sorghum vulgare*) and field pea (*Pisum sativum*). As the people continued to settle in the 1800s, there was a transition from shifting to cultivation to fallow based agriculture. Staple foods were millet (*Panicum miliceum*), finger millet and sesame (*Sesame indicum)*. The colonial government introduced other cash crops including groundnuts (*Arachis hypogaea*). During the early 1900's, maize production increased. Maize performed better than sorghum in areas with good rainfall and well drained soils.

As early as the 1940s, labour migration to Uganda, Nairobi as well as other Kenyan cities became an important livelihood strategy for the Luo. Average population density rose to about 50 people/Km2 by 1970. The population density in Kisumu district doubled between 1969 and 998 (Central Bureau of Statistics, 1996).

The intensive cultivation of food crops, including maize, using new husbandry practices such as frequent tillage, together with absence of soil protection measures, exacerbated soil erosion. This accelerated during the 1980s when soil degradation became widespread and crop yield started to decline

Research objective 1

The first objective of the study was to identify the causes of soil degradation in Kombewa division. To achieve this objective, the farmers were asked if they have experienced increased or decreased production over the past years and what could have caused the existing conditions. The results are presented below.

Table 3: What has been the general trend in your farm's productivity, increase or decrease?

Farm Productivity	Responses	Percentage
Increase	0	0%
Decrease	48	100%

All the farmers representing 100% admitted that they have experienced a decrease in farm production (Table 3). This was further supported by the Ministry of Agriculture's 2008 season's harvest records as shown in table 4

Table 4: 2008 season's harvest

Crop	Target	Acquired	Requirement	Deficit
Maize	246,250	149,620	650,000	500,380
Sorghum	86,580	74,230.4	150,000	75,769.6
Groundnuts	10,120	9,684	39,961	30,277

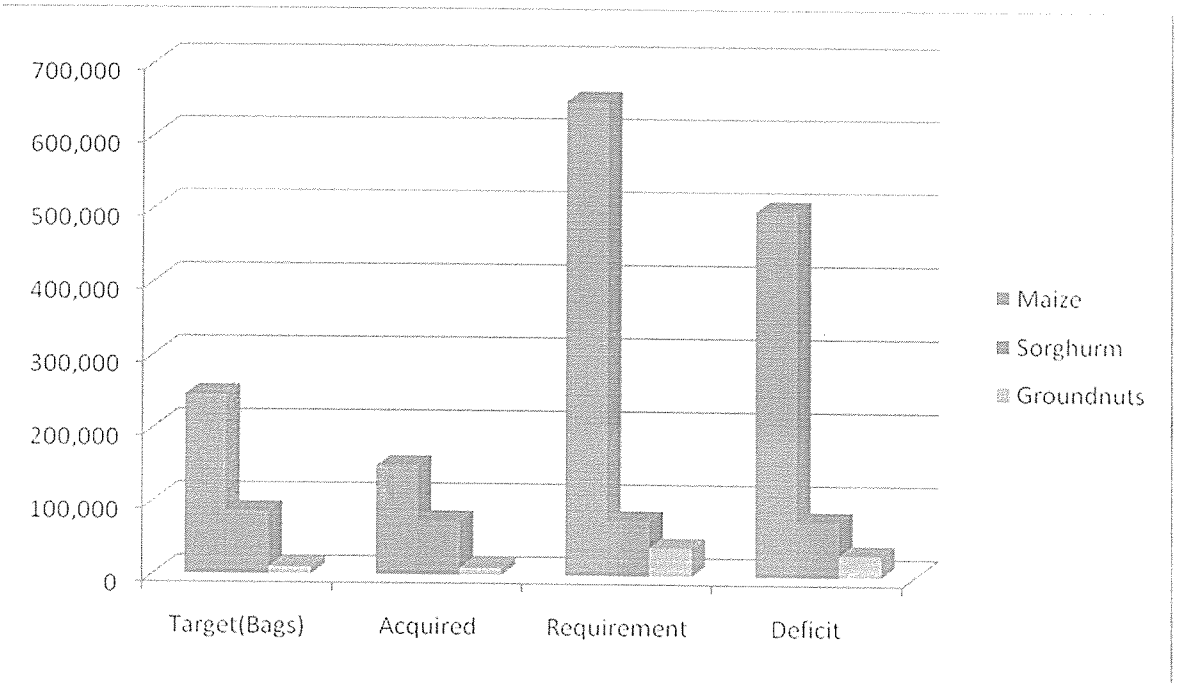

Fig 1:2008 Season's harvest

There is a great difference between the required quantities of various farm outputs and the acquired outputs. The discrepancy indicates that the population here requires more food but the land productive potential cannot meet these requirements. More so, the farm production is far much less than the targeted output with production deficits of 500,380 bags (77%) of maize,

75769 bags (51%) of sorghum and 30,277 bags (76%) of groundnuts (Fig 1). These deficits are so enormous that if no urgent recovery measures are put in place, and just as Jack and White 1999), put it, declining agricultural productivity from soil degradation will lead to scarcity of ood.

To identify the causes of the above trend lines, the respondents were asked to choose what could e the reason behind decreased production.

Table 5: What is the cause of decreased farm production?

Cause(s)	Responses	Percentage
Climate	32	26
Soil degradation	45	37
Pests and diseases	12	10
Financial constraints	25	20
Others	9	7

Source: Field work)

According to the results, 32 (26%) farmers attributed production decrease to climatic conditions changing weather patterns), 45 (37%) said soil erosion was responsible, 12 (10%) thought pests nd diseases was the responsible phenomena, 25 (20%) said they faced financial constraints hile 9 (7%) attributed it to other causes like inadequate knowledge of good farming practices Table 5).

Soil erosion was the dominant cause of decreased production. However, it should be noted that climate (unreliable rainfall) also contributed to a significant extend. Infact, soil erosion and climatic conditions are the major causes of decreased production (Larson, 1983).

Observations made revealed that nutrient depletion was apparent because even in areas that were not affected with soil erosion, stunted crop growth was spotted because of the inability of the soils to supply nutrients in the amounts, forms and proportions required for plant growth, Tenywa et al (1999) . Deficiencies particularly in nitrogen and phosphorus could be due to a variety of reasons, including naturally low inherent levels in the soil, continuous cropping, lack of crop rotation, removal of crop residue from the field, non application of sufficient organic and inorganic fertilizers, reduction of fallow period and soil erosion.

The farmers had their own way of assessing soil performance and conditions. Most farmers interviewed based their classification of soils basing on their surface layer. They codified a soil by colour, texture, and heaviness of working and soils have been given local names. Red soils (luala or Rauka) are regarded as the best soil for producing food crops. Farmers preferred the red soils for their high yields. Black soil, which is the second preference, is fertile but heavy and needed draining before it could be used.

Soil weakness was the term used by the farmers to indicate soil degradation. They used various indicators to assess the fertility of a field, such as yield, soil color, compactness, soil odor and the composition of the vegetation. According to the farmers, if the soil was alive and fertile, then crop yields were high. Farmers mainly assessed yields in terms of crop performance and less on the amount of crop harvested per unit area of land. The thickness of the ear of maize or the thickness of cassava roots were indicators of soil fertility. Soil color indicated the presence of

›rganic materials, soils with dark red color indicated that the soils were fertile. On soil ›ompaction, a fertile soil was rather soft and easy to work. When fertility declined, the soil ›ecame hard and more compact. The composition and performance of weeds and trees indicated he level of soil fertility. Most of the older farmers knew which species indicated a higher soil ertility such as black night shade (*Solanun nigram)*, pigweed (*Amaranthus hybridus),* thorn pple (*Datura stramonium*). Plant species that indicated poor soils were tick berry (*Lantana amara),* poverty grass (*Harpachne schimperi*) and black jack (*Bidens pilosa).*

ike most parts of the world, Kombewa division has had its share of the effects of climate hange. The changes in rainfall patterns had made most farmers abandon crop farming and urned their farms into grazing fields and this has increased the vulnerability of these fields to oil degradation.

inancial constraints also contributed to decreased production. Some of the farmers had the esire to use inorganic fertilizers but lack of finances held them back. The price of DAP is teadily increasing and now stands at Ksh. 2300 which is quite an investment for a poor farmer.

.4 Research objective 2

he second objective of the study was to assess the effects of soil degradation to the ommunities in the division. To achieve this objective, the respondents were asked to identify the kely impacts that they thought was as a result of soil degradation and how these impacts ffected their livelihoods.

Table 6: Impacts of soil degradation

Impacts	Responses	Percentage
Increased poverty levels	22	28%
Increased illiteracy levels	12	15%
Higher living costs	43	54%
Environmental deterioration	2	3%

Most farmers attributed the impacts of soil degradation to high costs of living at 54% (Table 6). The farmers said that the decreased production has led to inflation of basic foods because of their carcity in the market, Jack and White (1999). Infact, most households do not produce enough ood for their own consumption. This study established that about half of the respondents, epresenting 24 households were not self-sufficient and produced on average food to last them bout 7 months. Only 5-10produced a surplus. A 90kg bag of maize goes for between Ksh 2500 3200, an increase of about 45%. Most of the maize in the division come from traders in the eighboring rift valley province who sell them at exorbitant prices. 28% of the respondents felt neir poverty level was a result of soil degradation because most of them depend on farming for neir livelihoods. Decreased output meant less income for these farmers and even those who epended on hired farm labors were not spared since their employers could no longer sustain nem. High levels of school dropouts at 15% were also evident impacts. High living costs has led nany children to drop out of school to help their parents supplement their income through hired asual labors. Girls seek house help jobs while boys seek work in urban areas or in off-farm mployment such as trading or by working for private companies. The higher cases of school ropouts contributed to an increased level of illiteracy in the area since most of the children

acked complete basic education. As later discussed, illiteracy has contributed to non compliance o SWC measures. Only 3% considered environmental deterioration as an effect of soil legradation. Environmental deterioration was mainly brought by some members of the ommunity who turn to charcoal burning as an alternative source of income. In an area faced vith soil degradation like Kombewa, additional clearance of trees for charcoal burning ccelerated soil erosion. It was evident from the small number of the respondents, that only a few ad knowledge of the negative environmental implications of soil degradation. The narrowing of wach River in the area could be attributed and not limited to siltation. Only a small portion of ıe river had some algae growth although it was not evident enough if the growth was as a result f nutrient enrichment.

)bservations revealed that effects of soil erosion varied from one place to another. Moderate ullies were dominant in areas with slight slopes which could develop into big gullies if left nattended.

.5 Research objective 3

'he third and final objective of the study was to identify and develop systems that promote soil nd water conservation. The respondents were asked if they had any idea about soil and water onservation strategies.

Table 7: Do you have any idea of soil and water conservation methods?

	YES	NO
Respondents	12	36

Only 12 (25%) of the respondents were aware of any soil and water conservation methods. The majority 36 (75%) had no idea (Table 7). Of the 12 who had an idea in soil and water conservation, only 33% practiced them.

Table 8:Do you apply these methods in your farms?

	YES	NO
Respondents	4	8
Percentage	33	63

The 33% practiced physical measure that included fanya juu and fanya chini trenches and some applied organic manure though in much lower quantities (Table 8). However they were unaware of agronomic measures or other soil fertility improvement methods As far as the application of Farm Yard Manure (F.Y.M) was concerned, the 33% of the farmers stated that manure had improved soil fertility although according to the district agricultural office, the farmers applied an average 2 tones per hectare which is much lower than the recommended rate of 8 tones per hectare.

The farmers said the availability of the manure was constrained by the limited number of livestock and the tendency to graze the cattle away from the farm and transporting manure to the field is labour intensive which also limited its use.

Of those who did not practice SWC, 21% claimed that labour was one of the reasons. Of those who practiced SWC, 31% claimed that lack of labour was a constraint to increased investment (with 67% non-respondents). These figures suggested that lack of labour was not the main reason for not investing in SWC. It was a more significant constraint to increased investment for those who chose to adopt SWC practices.

Inorganic fertilizers were at least not used by all the respondents. The most important reason for not using fertilizers was lack of cash to buy it. Farmers also mentioned that inorganic fertilizers spoiled the soil and encouraged soil degradation. They argued that after using inorganic fertilizers for some time, the texture of the soil changed. The upper part of the soil became very fine and prone to erosion, while a hard pan appeared in the subsoil. The farmers also stated that soils become 'addicted' to fertilizers.

To develop systems of promoting soil and water conservation, the researcher together with the local farmers, developed a two year CAP to run from October 2010-october 2012 as shown in appendix 1.

`his study also found out important differences among households in the adoption of SWC vhich were related to differences in access to assets (i.e the ability to practice SWC) and the fit f SWC with livelihood strategies (i.e the motivation to adopt).

ı terms of assets:

- ✓ Farmers who rent rather than own land were less likely to invest in SWC
- ✓ Farmers with smaller farm sizes tended not to use SWC on any of their plots
- ✓ Access to knowledge was regarded as a key constraint to the adoption of SWC practice.
- ✓ Female- headed households tended to have less family labour and were less likely to invest in SWC.

ı terms of the fit of SWC with livelihood strategies: households that were dependent on crop roduction for their livelihood invested more on SWC.

Conclusions

The study investigated the causes and effects of soil degradation and established that soil degradation continues to be a major problem facing many farmers. It is caused by practices such as continuous cropping, lack of soil erosion control practices, removal of crop residues and insufficient application of manure and inorganic fertilizer. The underlying factors are increased poverty levels, a decline in livestock numbers and lack of cash.

In view of these findings, the study concludes that farmers in Kombewa will continue to experience soil degradation unless external efforts and supports are applied. The area has been abandoned and no extension services from the M.O.A are available to enhance the community's capacity of the problems associated with soil degradation. This has led many farmers to depend on their own IK (Indigenous Knowledge) and in cases where IK fails, nothing is done and this has discouraged many farmers who later abandon cultivation. This has increased poverty levels to these families because they depend mainly on farming for their livelihoods.

For soil fertility to be improved in this area, an integrated management practice must be a tool in hand. The area has potentials for crop growing if soil management practices are carried out.

Recommendations

overty has continued to be a thorn in the flesh to many societies and has hampered vital evelopments. The communities in this area need to be educated and informed on the advantages f their involvement in micro-financial institutions which provide soft loans with lower interest ates. This will improve their financial status and in turn ease the acquisition of necessary farm nputs to improve on their farm outputs.

he M.O.A should provide extension services through their extension officers to the farmers in rder to enhance the farmers' capacity concerning soil conservation practices.

oil conservation measures should be encouraged. Projects and programs must find ways of uilding on the skills, enthusiasm and knowledge of farmers. Some of the methods ecommended include;

nproved fallow with selected species of leguminous shrubs and herbs, especially *Sesbania esban* which performs best on soils that are deficient in both nitrogen and phosphorus. One of ie method involves the establishment of a 6 months fallow where the preffered crop , usually aize , is planted during the long rains. After harvest, an improved fallow species such as *esbania* is planted on the same piece of land during the subsequent short rains. Preliminary sults of trials in the neighboring Siaya district indicate that crop yields can be improved nsiderably.

he majority of soils in western Kenya are deficient in nitrogen, while maize is the major nsumer of this nutrient (Smaling, 1993). Manuring with green biomass is therefore another

nproved technology recommended for farmers in this area. The species used should have an xtremely high capacity for assimilating nutrients from the soil. The most common species are *'ithonia diversifolia* (wild sunflower) and *Lantana camara* (tick berry). Both species produce urge quantities of biomass that can be incorporated directly into the soil as green manure or used s mulch.

here should be increased adoption of small scale irrigated agriculture: This will focus on use of 'ater as an agricultural productivity improving input. Members should be trained on good rigation practices for high valued crops. While most of the production is rain- fed, there should e efforts to encourage use of small-scale irrigation practices with the smallholder farmers. onservation agriculture and the use of organic fertilizers (e.g., compost) are two xamples of sustainable agriculture practices that should be adopted in this area. Conservation griculture seeks to achieve sustainable agriculture through minimal soil disturbance (i.e., zero- : minimum-tillage farming—stubble tillage1), permanent soil cover, and crop rotations. The otential benefits from conservation agriculture will lie not only in conserving but also in nhancing the natural resources (e.g., increasing soil organic matter) without sacrificing yield vels. This increases the soil's water-retention capacities, and reduces soil erosion. It also cuts oduction costs by reducing time and labor requirements.

Given the aforementioned challenges to inorganic fertilizer adoption, a key policy tervention for sustainable agriculture should be applied to encourage adoption of agricultural chnologies that

ly, to a greater extent, on renewable local or farm resources. Organic farming practices, such as mpost and conservation tillage, are among such technologies. The water retention

haracteristics of these technologies make them especially appealing in this water deficient

ırming area.

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APPENDIX I

Community action plan

	Strategies	Materials/Resources	Sources	Duration	Remarks
	Chiefs' barazas Field demonstrations of various activities to be covered	Technical support	Agricultural extension officers	Oct 2010	Demonstrations will be done on selected farms.
n	Soil erosion control (Physical methods)	Technical support Tools Labor	Community	Nov 2010 to Aug 2011	Every farmer affected is expected to participate.
	Tree nursery establishment(agroforestry)	Seeds Technical support	Agricultural extension officers	Sep 2011 to July 2012	This will be a continuous activity
	Soil fertility improvement	Mulching Materials Compost Materials	Community	Jan 2011 to Oct 2012	" "

APPENDIX II

The questionnaire.

ear Respondent,

am a student of Kampala International University and am carrying out a study in your division
; a requirement for my degree. Your participation will be highly appreciated.

hank you,

NONDA EDGAR OCHIENG'

ECTION A

a) Name .....

b) Age (tick your category)

Below 30 years ☐

Between 31-39 years ☐

Between 40-49 years ☐

Above 50 years ☐

) Gender

Male ( ) Female ( )

ECTION B

(a)What has been the general trend in your farm's productivity?

Increase ( )

Decrease ( )

(b)What do you think could be the cause of decreased production?

Climate ( )

Soil degradation ( )

Pests and diseases ( )

Financial constraints ( )

Others ( )

In your own opinion, what are the impacts of soil degradation?

Increased poverty levels ( )

Increased illiteracy levels ( )

High costs of living ( )

Environmental deterioration ( )

(a)Do you have any idea of soil and water conservation?

Yes ( ) No ( )

)If yes, do you practice these methods in your farms?

Yes ( ) No ( )

)Give reasons for your answer in (b) above.

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