



SOUTH EASTERN KENYA UNIVERSITY

SCHOOL OF ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT

MASTER OF SCIENCE IN ENVIRONMENTAL MANAGEMENT

**ASSESSMENT OF ENVIRONMENTAL MANAGEMENT PRACTICES AMONGST
TOBACCO FARMERS IN KURIA WEST SUB-COUNTY, MIGORI COUNTY**

BY

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DECLARATION

Declaration by the student

I declare that this thesis has not been previously presented for a degree in South Eastern Kenya University, or in any other University. The work reported herein has been carried out by me and all sources of information have been acknowledged by means of references.

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Declaration by the supervisors

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

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DEDICATION

I dedicate this work to my lovely parents who have always been there to support and believe in my abilities always. Your encouragement, love, care and support has always seen me through even during the most difficult moments of my life. May God bless you with long life.

ABSTRACT

Kenya is one of the tobacco growing countries in Africa with most tobacco being produced in South Nyanza, Eastern and Western parts of Kenya. Despite the increasing deterioration of the environment caused by tobacco farming, very little is known about the measures in place to manage the situation. It is not clear to what extent the environmental management practices are employed in tobacco growing zones. Furthermore, it is not known how widespread the environmental degradation and environmental deterioration is in tobacco growing zones. The study focused on assessing environmental management practices being carried out by tobacco farmers to curb forest and soil degradation. The specific objectives were: to explore the impacts of tobacco farming on soil and forest resources; to identify the environmental management practices being practiced by tobacco farmers; and lastly to examine the environmental management practices being promoted by tobacco companies. The Data was collected from a sample of 173 tobacco farmers in Kuria West Sub-county. The data was collected through questionnaires, interviews, secondary data, direct observation, and taking of photos. The collected data was analysed descriptively using SPSS and Excel computer programme and was presented in bar graphs, pie charts, tables and texts. The research findings show that indigenous species in the study area disappeared over time because of tobacco curing with 60% respondent. Of the respondents, only 22% used improved barn while 78% used traditional barn which is non-energy saving barn, therefore consuming tonnes of wood compared to improved barns. The study showed that 98% of the respondents had not been advised by tobacco companies to use any other method to control pests except chemical pesticides and 97% of the respondents believed tobacco companies do not promote alternative source of energy for curing tobacco other than wood. The study indicated that there existed negative impacts to the soil and forest resources caused by tobacco farming. Although Farmers had adopted a few practices, most of the forest and soil management practices were non-existent in the study area and tobacco companies were yet to introduce them. On the other hand, tobacco companies were doing little to correct the situation. Most of the efforts by tobacco companies were directed towards ensuring good tobacco harvest and good quality cured leaves regardless of the harm caused to the environment. The study concluded that tobacco farming has adverse effects on the soil and forest resources, the very few existing environmental management practices practised by few tobacco farmers and tobacco companies were not adequate to mitigate the negative impacts caused by tobacco farming. To avert biodiversity loss, authorities should apply the laws strictly to curb cutting down of indigenous trees. On the same note, tobacco companies should consider promoting indigenous species for reforestation rather than exotic species. In addition, farmers should explore alternative ways of curing tobacco other than flue curing that have less impact to the forest resources.

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ACRONYMS AND ABBREVIATIONS

AGENDHA	Assistance and Management of Studies about Nature, Human Development and Agro-Ecology
ASDSP	Agricultural Sector Development Support Programme
ASH	Ash Fact Sheet
BAT	British American Tobacco
CBO	Community Based Organization
CTA	Technical Centre for Agricultural and Rural Cooperation
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
FAO	Food and Agriculture Organization
FCTC	Framework Convention on Tobacco Control
GOK	Government of Kenya
IDRC	International Development Research Centre
IEBC	Independent Electoral and Boundaries Commission
IRIN	Integrated Regional Information Networks
ITGA	International Tobacco Growers' Association
KEFRI	Kenya Forest Research Institute
KFS	Kenya Forest Service
LMICs	low and Medium Income Countries

NEMA	National Environmental Management Authority
NGO	Non Governmental Organization
°C	Degrees Celsius
OISAT	Online Information Service for No-chemical Pest Management in the Tropics
SAA	Sustainable Afforestation Association
SEKU	South Eastern Kenya University
SPSS	Statistical Programme for Social Sciences
UNEP	United Nations Environmental Programmes
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
USDA	United States Development Agency
WHO	World Health Organization

DEFINITION OF TERMS

The WHO Framework Convention on Tobacco Control (FCTC): WHO FCTC is an evidence-based treaty that was developed to address the issue of tobacco epidemic globally. The WHO FCTC represents a paradigm shift in developing a regulatory strategy to address addictive substances; in contrast to previous drug control treaties, the WHO FCTC asserts the importance of demand reduction strategies as well as supply issues (WHO, 2003).

Environmental management: Environmental management are measures and controls undertaken at individual, community, national and international levels and directed at environmental conservation to ensure that natural resources are allocated and utilized in a manner that will improve the quality of life for present and future generations (*UNEP, 1999*).

Environment: The environment is the multifaceted set of physical, geographic, biological, social, cultural and political circumstances that surround an individual or organism and that eventually determine its form and the nature of its existence. The environment impacts how individuals live and how societies develop. For that reason, people, progress, economic development and the environment are closely connected. The environment can also pose risks. Air pollution, waterborne diseases, poisonous chemicals, and natural disasters are some of the challenges the environment presents for mankind (World Bank, 2012).

Environmental degradation: Environmental degradation is the deterioration in environmental quality from ambient concentrations of pollutants and other activities and processes such as improper land use and natural disasters (United Nations Statistics Division, 1997).

Deforestation: According to the University of Michigan (2010), deforestation is the conversion of forest to another land use or the long-term reductions of the tree canopy cover below a 10 percent threshold. It is also the long-term or permanent loss of forest cover and its transformation into another land use.

Purposive sampling: Purposive sampling is described as a random selection of sampling units within the section of the population with the most information on the characteristic of interest. Purposive sampling enables you to use your judgement to select cases that will best enable you to answer your research question(s) and to meet your objectives (Saunders et al, 2012).

Tobacco curing:Curing is a cautiously controlled process used to attain the texture, colour and total quality of tobacco crop. Throughout the cure, leaf starch is converted into sugar, and the tobacco changes colour from green to lemon, to yellow, to orange to brown (BAT, 2016).

CHAPTER ONE

1 INTRODUCTION

1.1 Background to the study

Commercial tobacco production started in Chesapeake Bay area of Virginia (USA) in the early 17th century; it was an enterprise of settlers making use of contract and slave labour to exploit natural environments (Geist, 1998). Goodman (2005) states that in 1800, 70% of world tobacco production was concentrated in North America and starting with the American Revolution and with the breakdown of colonial rule, tobacco production spread all over the world. The biggest producer in the world as at present is China which produces a third of the world's tobacco (Eriksen et al, 2015). Geist (1999) points out that since the late 1970s, concerns have been registered by several environmental agencies including Food and Agriculture Organization (FAO) and the World Health Organization(WHO) regarding the impact of tobacco growing to the environment. The tobacco crop itself entails a high degree of maintenance, including pest and disease control, regular water supply and fertilizers to enhance yield.

The history of tobacco farming in Kenya dates from 1907 when BAT set up a marketing body with its base at Mombasa (WHO, 2012). The firm focused in building supply network all over East Africa. WHO (2012) indicate that in 1957, a modern tobacco and cigarette factory began operations in Nairobi to serve what BAT referred to as 'special needs' of an increasing Kenyan market. Until 1975, BAT Kenya mainly depended on Tanzanian and Ugandan tobacco for the manufacture of local brand, later on tobacco companies chose to introduce the growth of tobacco in appropriate areas by small scale farmers in Kenya (Kweyuh, 1994). Ever since tobacco farming was introduced, it has increased greatly over the years. According to the GoK (2013), there were 36,000 tobacco farmers in Kenya and tobacco crop covered approximately 20,000ha with estimated total output of 20 million kilograms of dried leaf worth about Kshs. 2.0 billion. The Kenyan Government just like other developing countries, treasures the tobacco companies because of the profits generated by the tobacco firms through taxes paid. It is confirmed that between the tobacco firms, the farmers and the government, it is the government that is the utmost beneficiary (WHO, 2009). For instance, in 1997, BAT Kenya Ltd - one of the leading tobacco firms in the country - had a gross turn-over of over Kshs. 10 billion and remitted over Kshs. 6 billion to the government. During the same period the farmers in the country earned about Kshs.

900 million (WHO, 2009). According to GoK (2013), tobacco farming takes place in Kuria Migori, Suba, Homabay, and Rachuonyo, Bungoma, Busia, Teso and Mount Elgon, Kirinyaga, Muranga, and Thika, Meru, Kitui and Machakos. However, most of the 80% tobacco production is taking place in the Migori and Homabay Counties.

American University, (2006) wrote that the Malawi's forests were at risk because they could not endure the pressure being put on them by tobacco industry and population growth for much longer. Many negative environmental and social costs were anticipated if the forest destruction continued in Malawi. This was quite ironic because tobacco, a crop that was perceived as Malawi's key for economic development was leading the country to its demise (American University, 2006). In Kenya tobacco companies have been established to promote tobacco farming activities in the country, which has been successful since they provide free technical advice to farmers and loans to purchase fertilizers and pesticides. This has contributed to intensified tobacco production in various parts of the country and this is likely to encourage further environmental degradation through excessive use of fertilizers, pesticides and deforestation.

However, limited studies have been done to indicate whether there are any environmental management practices in place to control further environmental degradation. One such study on environmental management practices include use of improved furnace which can save up to 10-20% of fuel consumed per tobacco leaves cure (Gwata, 2011). These are mostly practiced in the developed countries, but they are yet to be reported in Kenya. Essentially, the study focused on identifying the impacts of tobacco farming to the forest and soil resources and environmental management practices carried out to restrain further deterioration of the forest and soil resources and also cross examine the environmental management practices being promoted by tobacco companies to protect the soil and forest resources.

Kuria West Sub-county was chosen as a study area because it has been one of the best producing tobacco zones in Kenya for a long time. This study focussed on two major environmental resources that are the most affected by tobacco farming that is forest and soil resources. Environmental management practices such as crop rotation, use of renewable sources of energy, cover crops, contour farming, and strip cropping are yet to be reported in tobacco farming areas particularly in Kenya especially in the study area. Therefore, this study endeavoured to identify

environmental management practices amongst tobacco farmers in the study area. In addition, there is no literature on the impact of tobacco farming on soil resources and no study has elaborated the roles tobacco companies as well as tobacco farmers are playing to curb the menace of environmental degradation caused by tobacco farming in the study area. This study explored the impacts of tobacco farming on soil resources and as well identify the roles tobacco farmers and tobacco companies are playing to control environmental degradation.

1.2 Research Problem Statement

Despite the increasing deterioration of the environment caused by tobacco farming, it is not certain if environmental management practices exist in the study area to contain the situation. The environmental management practices such as afforestation, use of renewable source of energy, use of improved barns, soil management practices e.g. strip cropping, mulching and cover crops are being practiced in some countries especially the developed countries but they have not been reported in Kenya especially Kuria West Sub-county.

The studies on the impact of tobacco farming to soil resources in the study area have not been done and the studies done on impact of tobacco farming on forest resources are not as exhaustive as they should be. For instance, studies done on tobacco have not identified the indigenous tree species that have disappeared over time as a result of tobacco farming. Therefore, this study endeavoured to explore impacts of tobacco farming to forest and soil resources as well as environmental management practices that were being carried out by tobacco farmers to control forest and soil resources degradation linked to tobacco farming. Lastly, the study explored the roles that were being played by tobacco companies to promote sound environmental management practices amongst tobacco farmers.

1.3 Objectives of the study

Overall objective

To determine the environmental management practices applicable to tobacco farming to curb soil and forest resources degradation in Kuria West Sub-County.

The specific objectives are:

1. To assess the impacts of tobacco farming on soil and forest resources in Kuria West Sub-county.
2. To examine the environmental management practices being practised by tobacco farmers to contain soil and forest degradation.
3. To evaluate the environmental management practices promoted by tobacco companies to control soil and forest resources degradation.

1.4 Research questions of the study

1. Does tobacco farming have negative impacts on soil and forest resources?
2. Are there existing environmental management practices being carried out by tobacco farmers to contain soil and forest resources degradation?
3. Are there environmental management practices being promoted by tobacco companies to protect soil and forest resources from degradation?

1.5 The scope of the study

This study was designed to examine the environmental management practices amongst tobacco farmers. However, the study focussed on only two environmental resources that are adversely affected by tobacco farming, that is; soil and forest resources. The data collected was qualitative and quantitative and it limited itself to the major actors involved in tobacco farming who are tobacco farmers and partially Kenya Forest Service. In geographical terms, the research was focussed on Kuria west Sub-county, one of the major tobacco growing zones in Kenya. The findings of this study were intended to be generalized to other tobacco growing zones in Kenya.

1.6 Justification for the study

Extensive deforestation, excessive use of fertilizers and pesticides that cause soil toxicity, monoculture that exhaust the soil nutrients has been witnessed in tobacco growing zones, Kuria West included. If these trends continue, we are likely to witness an unceasing environmental degradation. Therefore, there is need for appropriate measures to be put in place to control further forest and soil resources degradation in Kuria West, This is to ensure the environmental quality and the livelihood of the people are not compromised. This study focussed on two environmental resources; soil and forest resources. The resources were chosen based on the fact that most studies have established that they are the most affected by tobacco farming.

This research was therefore important in exploring the impacts of tobacco farming to forest and soil resources. The research further identified the environmental management practices that were being carried out to restrain soil and forest degradation as well as examined measures being initiated by tobacco companies and other stakeholders to curb soil and forest dilapidation.

The results of the study may be valuable to policy-makers because it brings out the status of the environment in the tobacco growing zones and the need to create laws and enforce the existing ones to control the negative impacts of tobacco farming. The study will enable WHO Framework Convention on Tobacco Control (FCTC) to understand the progress that has been made as far as the implementation of article 17 and 18 of the treaty is concerned. National Environmental Management authority (NEMA) on the other hand will see the need to promote the integration of environmental considerations in tobacco farming with a view to ensuring proper management and rational utilization of environmental resources as well as advise the Government on the implementation of the WHO FCTC to which Kenya is party. The Study is also of value to Environmental planners, NGOs and CBOs engaged in improving and promoting environmental quality because it will enable them plan and initiate projects aimed at environmental conservation in the tobacco growing zones. The study has provided some important information on how to control environmental degradation by upholding good environmental management practices among tobacco farmers.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

In this chapter, available literature was critically reviewed with regard to research work previously done on various environmental impacts associated with tobacco farming as well as the environmental management practices being applied to control environmental degradation. This enabled the researcher to identify the research gaps that needed to be filled in relation to the objectives of the research.

2.2 Impacts of tobacco farming to forest and soil resources

Kuria West Sub-county was chosen as a study area because it has been one of the bestproducing tobacco zones in Kenya for a long time. It is important to note that the study area grows only Virginia type of tobacco that requires flue curing. As at 2001, the study area was producing 80% of total tobacco export from Kenya, (Chacha, 2001). Therefore, we expect environmental degradation to be severe in this area due to the negative environmental impacts connected with tobacco farming. However, the situation might have changed to some extent after the introduction of alternative livelihood to tobacco farming for the last six years (Kibwage et al., 2014) in some parts of Kuria West Sub-county, but it is essential to note that tobacco crop is still the main cash crop of the area (Chacha et al., 2010).

This study focussed on two major environmental resources that are the most affected by tobacco farming; that is forest and soil resources. According to the WHO (2009), the negative consequences of tobacco farming are evidently perceptible in the form of forest destruction and soil degradation. Lecours et al. (2012) also highlighted two main environmental effects of tobacco farming in their literature review: deforestation and soil degradation.

In the developing world, vegetation is often cleared to make room for tobacco crops and more trees are cut down for use during the curing process. After harvesting, tobacco is cured either by air, sun or fire; curing enhances the flavour of tobacco and increases, by reducing the moisture level of the leaf, tobacco's preservability (ITGA, 2015). This way it can be stored for a relatively long

time without perishing. Curing of harvested tobacco leaves is done after harvesting to preserve it for storage, transport and processing(Phillip Morris International, 2011).

According to the African Union (2007) vegetation loss of almost 50% has occurred because of the conversion of land for tobacco production and the wood as fuel for curing. Another study by Tobin and Knausenberger (1998) indicates that Malawi (a leading country in tobacco production in Africa) is estimated to be losing 3 percent of its forests cover every year due to tobacco production and this is considered to be one of the fastest rates of deforestation in the world today. By early 1990s, the Malawi government acknowledged that it had one of the highest rates of deforestation in the world (Tobin and Knausenberger, 1998).

Geist (1998) points out that the damage tobacco farming is causing to the forest resources was alarming especially in the developing countries where tobacco is grown, including South Korea, Uruguay, Bangladesh, Malawi, Jordan, Pakistan, Syria, China, Zimbabwe, Argentina, Tunisia and Burundi. Geist (1998) states that the levels in these developing countries were too high (above the national mean average of 4.6%). Contrarily the impact of tobacco farming on woodland in developed regions such as Canada and North America, where there was a net increase in forest cover, was low (Geist, 1998).

A report by Panos (1994) further emphasizes that the near depletion of both the natural and planted vegetation is the most striking effect of tobacco production. The report points out that planted forests in Uganda covered 7,225 hectares in the early 1970s, but had been reduced to about 3,000 hectares as a result of tobacco farming, with Maracha in the West Nile being the most affected area by deforestation. If something was not done at that moment, Maracha was to be a desert. The report further noted that deforestation has caused wells and streams in the area to dry up, forcing people to walk further in their search for fuel wood and women, already working long hours, have shouldered most of this extra burden.

Forests destruction is a major issue in Kenya as well in recent years. This has enhanced the increased risk of drought and damage to the economy(IRIN Nairobi report, 2005). A study by Kibwage et al (2014) for instance on deforestation resulting from tobacco farming only pointed out how tobacco farming has led to the massive destruction of natural and man-made forests.

According to Lecours (2014), Tobacco leaves entail use of huge amount of fuel wood which is not required for other commercial cash crops. But studies showing the role the tobacco companies play to counter-check the problem are lacking. This study addressed the part tobacco companies are playing towards addressing this issue of deforestation.

Not only has tobacco farming led to massive forest destruction but also soil degradation. Deforestation in tobacco growing areas is mostly accompanied by adverse soil erosion. For instance, in Aura Sub-county of North West Uganda which is a tobacco growing area, sheet erosion is very evident and much of the topsoil has been washed away, (ASH, 2009). Soil erosion is the main driver of desertification. Desertification renders the land unproductive, and hence soil erosion control is very significant.

The intensive cultivation associated with tobacco growing accelerates soil erosion in tobacco growing areas. Ontario Ministry of Agriculture (2009) states that tobacco soil is prone to wind and water erosion which means that soil which has been used to grow tobacco sometimes does not support the growth of other crops even though tobacco growing is rotational, with different crops being planted in alternate years. This shows that tobacco farming can easily lead to food insecurity in tobacco growing zones if not well regulated and soil erosion control mechanisms are not in place. However, there is no literature on soil degradation/erosion in the study area caused by tobacco farming.

In some countries, such as Malawi, Sri Lanka, Zambia and Zimbabwe, where tobacco is grown on hilly land, soil erosion has been greatly accelerated causing irreplaceable damage (Panos, 1994). In Sri Lanka where tobacco grows on hillsides close to the Mahaweli River, trees have been cut down causing the hillsides to become almost bare, and without the protection of trees, topsoil is washed into the river. This causes severe problems downstream, with the deposition of soil in the river causing silt problems for the Victoria dam scheme, built in the 1980s (Panos, 1994).

Studies done indicate that tobacco is a nutrient demanding crop. Intense tobacco cultivation contributes to poor food supply and causes soil aridity. Tobacco uses more primary soil nutrients (Nitrogen, Phosphorous and potassium) than most cash and food crops (Leucors, 2014). The impact is therefore severe in tropical countries which have low soil nutrients, (Ochola and Kosura,

2007). This has led to low soil fertility that has resulted to food insecurity in tobacco growing zones.

Few studies such as the one done by Chacha (2001) have attempted to elaborate on the impacts of tobacco farming to forest resources. However, there is no literature on the impact of tobacco farming on soil resources in the study area.

2.3 Environmental management practices amongst tobacco farmers

A study by Kibwage et al. (2014) recorded the stages in tobacco farming activities. This is summarized in figure 2.1. Various socio-economic, human health and environmental concerns have been recorded at all these stages.

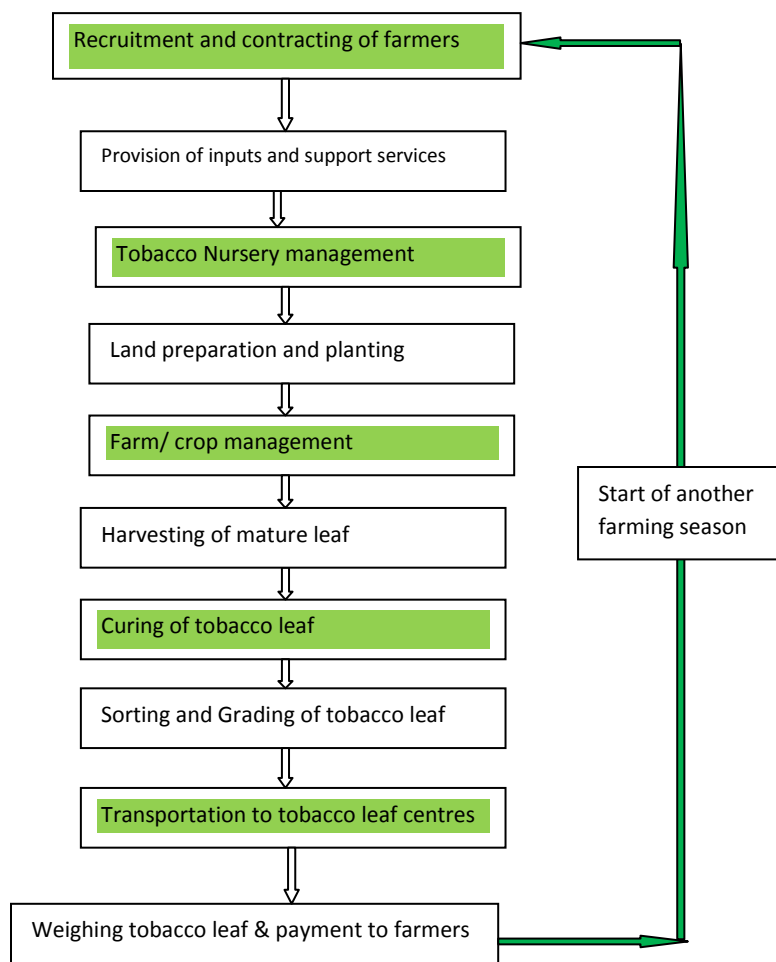


Figure 2.1: Steps involved in tobacco farming

Source: Kibwage et al. (2014)

Therefore, it is important to ensure management practices are observed at every step to address environmental concerns involved. Several environmental management practices have been carried out worldwide to minimize forest and soil resources destruction; this includes crop rotation, reforestation, use of improved furnace, use of renewable sources of energy, cover crops, contour farming, and strip cropping among others (Moore, 2009). However, it is worth noting that such practices are yet to be reported in tobacco farming areas particularly in Kenya especially in the study area. Therefore, this study endeavoured to identify environmental management practices amongst tobacco farmers in the study area.

The significance of crop rotation on diseases, insects, and nematodes reduction has been well documented. Moreover, crop rotation is important for reducing weed problems. Many weeds, especially the large seeded broadleaf weeds such as sicklepod, cocklebur, and Florida beggarweed, can be more effectively controlled in other crops such as maize or sorghum, and tobacco, (Moore, 2009). Tobacco is a nutrient demanding crop hence there is need to rotate it with crops that can fix nutrients into the soil. Tobacco being a monocrop encourages the development of weeds, diseases and pests. Crop rotation with crops such as beans, Redtop, hairy crabgrass, lespedeza, soybeans, and crotalaria have been known to reduce weeds and diseases such as bacteria wilt, fusarium and root knot in Georgia (Gaines and Todd, 2010). However, such practices are yet to be reported in tobacco farming areas particularly in Kenya.

Use of improved furnace in tobacco leaf curing is another important management practice that can protect our forests from destruction. Flue-cured tobacco is more preferred to air cured because it sells at a higher price in developing countries (Gwata, 2011). Gwata (2011) further states that after harvest, the virginia type of tobacco undergoes curing in a specialised barn in which heated air extracts water from the tobacco leaves. These barns are usually fuelled by wood and the drying process lasts seven days (Gwata, 2011). It is evident that tobacco curing entails excessive wood consumption. It is estimated that a barn with well-insulated walls, roof and floor can save 10-20% of fuel consumed per cure (Gwata 2011). As Reed (2009) notes, harvesting ripe tobacco can be another practical energy-efficient curing measure, which requires a shorter curing time and thus less heat loss and wood consumption. The average fuel consumption is two kilograms of coal for each kilogram of cured tobacco. Efficient curing management and improved barn structures in Zimbabwe will enable small-scale growers to improve this figure to 1.2kg of coal for each kilogram of cured leaf (Reed 2009). A new concept of tobacco curing by means of recycling hot

air is being tested in Zimbabwe (Matibe, 2011). This has the advantage of being more energy efficient. However, researches on improved barn are not far-reaching. The use of such improved curing barns in tobacco growing zones especially in Kenya to cure tobacco has not been documented. This study endeavoured to explore whether there are any improved barns for curing tobacco in the study area.

Since tobacco curing in tobacco growing zones has always been largely associated with deforestation, it is important to look for alternative ways of curing tobacco that are environmentally friendly to alleviate the problem. Other curing technologies around the world with less environmental impacts are air curing where by tobacco is hung in well-ventilated barns and allowed to dry for a period of 8 weeks (University of Kentucky, 2014). Sun curing exposes leaves to the sun to remove most of their moisture before being air-cured to complete the process (ITGA, 2015). The remaining two technologies for curing tobacco that is flue curing and fire curing uses wood to cure tobacco, therefore contributing to deforestation in tobacco growing areas.

Using renewable source of energy such as solar energy seems to be a better alternative. In Malawi, a project working with tobacco farmers is proving that solar-generated electricity can play a useful part in agricultural production as well as environmental conservation. The project is focusing on the curing of tobacco. The technology permits sample control of the temperature in the curing barn, reducing the time required to cure the leaves by half and greatly reducing the quantity of logs used in the process (Technical Centre for Agricultural and Rural Cooperation (CTA), 2003). However, no studies have indicated whether this type of practice exist in the study area. Hence this study explored whether such options of sources of energy for curing tobacco exists in Kuria West Sub-county.

It is important to note that cover crops which are planted to protect and improve the soil without the intent of being harvested have proved to be very effective. Hoyt (2011) notes that winter cover crops have been used in the United States of America for burley tobacco production and they have proved to be effective in minimizing soil erosion and maintaining organic matter in the soil. Soil should be covered with living crops or crop residues for as long time as possible to prevent losses by erosion or the harmful action of extreme temperatures. As discussed earlier, tobacco is a nutrient demanding crop and it's susceptible to erosion; a cover crop can come in handy in reducing these negative effects to the environment. Some of the plants that have been

dominantly used as cover crops in USA in tobacco farms include Oats, Wheat, rye, barley, triticale, ryegrass and legumes. These cover crops also provide pastures for grazing animals and straw (Hoyt, 2011). Cover crops are common in Kenya among non-tobacco farmers, but no studies have indicated whether they are being practised by tobacco farmers in the study area or elsewhere. The study therefore endeavoured to determine whether cover crops are being used in tobacco farms and if so identify the kind of cover crops being used in the study area.

Zero tillage is another efficient method of controlling soil degradation. Tillage is conventionally used to reduce weed pressure, but can leave soil more prone to erosion. Zero tillage has an advantage of superior soil conservation, moisture conservation, reduced water runoff, the long-term build-up of organic matter, and increased water infiltration (Sullivan, 2003). A soil managed without tillage relies on soil organisms to take over the job of plant residue incorporation formerly done by tillage. No-tillage options, such as direct drilling combined with the use of herbicides or mechanical weed removal, may be effective, either long-term or occasionally in a rotation depending on the soil and weed pressure. However, care is needed to ensure that soil surfaces do not “crust” and become impermeable, which increases erosion (Unilever, 2010). Due to all the problems associated with conventional tillage operations, acreage under reduced tillage systems is increasing on the American landscape. Any tillage system that leaves more than 30% surface residue is considered a "conservation tillage" system by USDA (Magdoff, 1992). Conservation tillage includes no-till, zero till, ridge-till, zone till, and some variations of chisel ploughing and disking.

In contour farming, tillage and planting operations are carried out along contours, thereby reducing erosion arising from water and soil flow down the slope. If the erosion risks are high (or slope greater than 10%), strip-cropping may be appropriate, where a strip of grass or close-growing crop is alternated with the main crop. The permanent or semi-permanent strips slow down runoff and trap eroding soil. On steeper slopes, terracing is appropriate, (Unilever, 2010). However, the study done on contour farming/strip cropping by Unilever (2010) lacked scientific method of approach, thus this study employed the scientific method to achieve its objectives.

Mulching enhances the activity of soil organisms such as earthworms. It forms a soil structure with sufficient smaller and larger pores to allow rainwater to easily penetrate the soil, consequently reducing surface runoff. When the mulch material decays, it upsurges the content

of organic matter in the soil. Organic matter in the soil aids in creating a good soil with firm crumb structure. Therefore, this prevents soil particles from being carried away by water. Thus, mulching plays a critical part in averting soil erosion (FAO, 2012). Besides that, in the long term, the role of mulch will be similar to that of forest litter layer, thus effectively reducing the surface runoff hence resulting very low level of erosion, increase the soil organic C, total N and can the activity of microorganisms in the soil (Suyana and Senge, 2010).

2.4 Promotion of Environmental management practices by tobacco companies

Tobacco companies always want to portray themselves as being environmentally conscious by asserting that they have adopted and encouraged sustainable and low-impact practices from farm to factory. However, in as much as the companies try to show that they are spearheading environmental conservation activities, this has not erased the detrimental impacts of tobacco farming to the environment. In addition, no study has elaborated the roles tobacco companies are playing to curb the menace of environmental degradation caused by tobacco farming in the study area.

Being aware of the important role wood plays in curing tobacco and in building barns, especially in areas where wood is a scarce and resources are under pressure BAT Company endeavours to sponsor and promote afforestation programmes to ensure a supply of wood to tobacco growers and promote biodiversity considerations, (BAT, 2010). However, it is not clear whether these afforestation and reforestation programmes by BAT are bearing any fruits. Panos (1994) writes that in Kenya for instance, BAT encourages farmers to plant many eucalyptus trees on their land, but the size of land is not enough to accommodate the number of trees proposed by BAT. Furthermore, several tobacco growers choose to use trees such as eucalyptus for construction purposes and so continue to clear indigenous forest for tobacco curing. This criticism shows that efforts by BAT for reforestation and afforestation programmes may well not be making any impact to reverse the on-going deforestation activities caused by tobacco production.

The International Tobacco Growers' Association (ITGA) a non-profit organization that claims to be presenting the interest of tobacco growers around the world insists to be upholding environmental conservation through sensitizing its members the importance of using alternative energy to fuel and promoting reforestation programmes. The association points out further that planting of trees or voluntary initiatives organised through growers' associations, preserving a

country's natural resources has long become a priority in the tobacco-growing sector. This association has gone further to indicate how tobacco growers have played an important role in reversing deforestation in tobacco growing zones such as Southern Brazil, (ITGA, 2015). However this might not be the case in other tobacco growing zones since tobacco-related environmental problems that were documented in Africa in the 1990s are still present, including widespread deforestation and the felling of indigenous trees for curing (Lecours et al, 2012).

Apart from sponsoring forestry programmes, British American Tobacco encourages farmers to use non-wood fuels, as well as using packaging materials from suppliers who use sustainable sources as stated in their website (BAT, 2010). Philip Morris International (2011) on the other hand developed 'Good Agricultural Practices' guidelines, which encourages reforestation and dispirits deforestation. However, there is no evidence of the reforestation programmes being successful.

Soil conservation upholds or improves the productive capacity of the land in parts affected by or predisposed to degradation (FAO, 2015). Tobacco farming is known to degrade soil to a point where the soil cannot support crop production. However, BAT asserts to be promoting sound soil conservation measures in countries such as Brazil and Bangladesh by replenishing soil fertility using organic matter and green manure as well as encouraging farmers to plant on high and wide ridges to slow down soil erosion (BAT, 2010).

2.5 Tobacco control policies and Laws and international Agreements

I. Constitution of Kenya

The Constitution of Kenya, promulgated into law on 27th August, 2010 is the supreme law of the Republic of Kenya and binds all persons and all State organs at all levels of government. It provides the broad framework regulating all existence and development aspects of interest to the people of Kenya, and along which all national and sectoral legislative documents are drawn. In relation to environment, Article 42 of Chapter 4, the Bill of Rights, confers to every person the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative measures, particularly those contemplated in Article 69, and to have obligations relating to the environment fulfilled under Article 70 (GOK, 2010). Article 69(g) of the constitution states that the state shall

eliminate processes and activities that are likely to endanger the environment. Article 70 of the constitution states that:

1. If a person alleges that a right to a clean and healthy environment recognised and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.
2. On application under clause (1), the court may make any order, or give any directions, it considers appropriate—
 - a. to prevent, stop or discontinue any act or omission that is harmful to the environment;
 - b. to compel any public officer to take measures to prevent or discontinue any act or omission that is harmful to the environment; or

In conformity with the Constitution of Kenya 2010, every activity or project undertaken within the Republic of Kenya must be in tandem with the state's vision for the national environment as well as adherence to the right of every individual to a clean and healthy environment. It is at this point that tobacco farming activities should be evaluated to identify their impacts and the environment management practices to ensure that the right of persons to a clean and health environment are not compromised. The constitution provides an opportunity for action to hold the tobacco companies accountable for actions that causes destruction to the environment, it is the responsibility of the relevant authorities and policy makers to implement and omit harmful/destructive processes and activities associated with tobacco farming.

II. Tobacco Control Act of 2007

The object and purpose of this Act is to protect and promote the interest of tobacco growers by providing viable alternative crops. Inform educate and communicate to the public the harmful health, environmental, economic and social consequences of growing tobacco.

Part III Section 9 of the Act states that the Government shall promote public awareness about the harmful effects of tobacco growing and handling through a comprehensive nation-wide education and campaign conducted by the Government through the relevant ministries, departments, authorities and other agents. Section 13(1,2) indicates that the Minister for the time being in charge of Agriculture shall put in place policies to promote as appropriate, economically viable

alternatives for tobacco farmers (GOK, 2007). The Government through relevant Ministries shall put in place policies to promote, as appropriate economically viable alternatives for tobacco workers, retailers, distributors and individual sellers.

The government through this Act acknowledges the undesirable effects tobacco has to the environment and therefore the Act was formulated to regulate tobacco production and as well promote viable alternatives to the tobacco that have minimal impact to the environment.

WHO Framework Convention on Tobacco Control

WHO FCTC provides a roadmap to comprehensive global tobacco control programs and strategies at the international, national, regional and local levels; The objective of the instrument is to: protect present and future generations from the devastating health, social, environmental, and economic consequences of tobacco consumption and tobacco smoke exposure.

The WHO FCTC is a worldwide known international agreement that creates the machinery to promote tobacco-control programs at the national level through multi-lateral cooperation (WHO, 2003). Kenya signed and ratified the FCTC and is therefore bound by the guidelines to article 17 and 18.

With Article 17 being specific on the provision of support for economically viable alternative activities for tobacco workers, growers and, as the case may be, individual sellers. While Article 18 deals with the protection of the environment and health of persons in respect of tobacco cultivation and manufacture within territories of Parties.

2.6 Summary of the research gaps

Apparently, there exist a few environmental management practices by tobacco farmers and companies. However, there are some gaps in this literature. Most of these environmental management practices were carried out in developed countries such as crop rotation, use of renewable sources of energy, cover crops, contour farming, and strip cropping among others. Such practices are yet to be reported in tobacco farming particularly in Kenya especially in the study area.

Few studies have attempted to elaborate the impacts of tobacco farming to Forest resources. However, there is no literature on the impact of soil degradation/erosion in the study area caused

by tobacco farming. Therefore, this study investigated the impacts of tobacco farming on soil resources in the study area.

The studies done indicate that there exist environmental problems in most tobacco growing zones. However, studies showing the role tobacco companies play to counter-check the problem are lacking. This study addressed the initiatives carried out by tobacco companies to address the environmental challenges in the study area.

There exists use of improved barns for curing tobacco which are energy efficient. However, the use of such improved curing barns in tobacco growing zones especially in Kenya to cure tobacco has not been documented. This study endeavoured to explore whether there are any improved barns for curing tobacco in the study area. Using renewable source of energy such as solar seems to be a better alternative for curing tobacco. Nevertheless, no studies have indicated whether this type of practice exist in the study area. Hence this study explored whether such options of sources of energy for curing tobacco exists in Kuria West Sub-county.

Cover crops are common in Kenya among non-tobacco farmers, but no studies have indicated whether they are being practised by tobacco farmers in the study area or elsewhere. The study therefore endeavoured to determine whether cover crops are being used in tobacco farms and if so identify the kind of cover crops being used in the study area.

CHAPTER THREE

3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter highlights the methodology on which the research was carried out, data analysis techniques, methods applied to realize the objectives and goals of this study, key research variables sampling procedures / methods, sample size determination and reconnaissance survey. The study was carried out in two administrative sub-locations which are the main tobacco growing zones in Kuria West i.e. Ikerege and Nyametaburo Sub locations.

3.2 Study area

Migori County is located in the south-western part of Kenya. It borders Homa Bay county to the North, Kisii and Narok counties to the East and the United Republic of Tanzania to the South. Lake Victoria borders the county to the West. The County covers an area of 2,596.5 km² including approximately 478 km² of water surface (ASDSP, 2016).

The county has 7 sub-counties, 23 divisions, 76 locations and 174 sub-locations. Migori subcounty has the highest number of administrative units while Uriri sub-county has the smallest number (IEBC, 2012).

Table 3.1: Administrative and political units

Sub-county	Divisions	Locations	Sub-locations
Migori	3	15	30
Nyatike	5	13	26
Kuria East	4	13	26
Kuria West	5	14	30
Awendo	2	7	21
Uriri	2	7	19
Rongo	2	7	22
Total	23	76	174

Source: IEBC (2012)

The population of Migori County according to the Kenya National Bureau of Statistics (2009) population census was 917,170 comprising of 444,357 (48.6%) male and 472,814 (51.4%) female. This was projected to increase to 1,028,028 persons in the year 2012 and with a population growth rate of 3.8 per cent per annum, the population is expected to stand at 1,152,165 persons in 2015 and 1,243,272 persons in the year 2017.

Migori County has an arable land of about 1,800 km² of which 666 km² is grown crops, water mass covers an area of 475 km² and 60% of cultivated area is under cash crop, 30 per cent under food crop and 10 per cent is fallow. Migori County has productive soils with favourable conditions appropriate for farming activities. The remaining area is non-arable primarily owing to undependable rains in some constituencies such as Nyatike and Kuria West. Most lands have not been adjudicated in the county and 60% of the inhabitants do not have ownership documents particularly in Nyatike sub-county. Land in the County is mostly owned communally and this could perhaps clarify the reason why the average farm dimensions for the small-scale farms is 3 acres while it is 7 acres for large-scale farms (ASDSP, 2016).

The key economic activities in the County include agriculture, fishing, manufacturing and mining. There is some small-scale gold mining carried out in the County. The County also sees some limited commercial activity, mainly small and micro-enterprises in the Jua Kali sector. These include auto mechanics, furniture works, tailoring, welding, trade and agriculture (Migori County, 2012).

Crop farming is the largest economic activity among the residents of Migori County taking the largest portion of the land in the region. The land is graded under arable land which can support considerable crop yields through rain fed agriculture. Less irrigation is taking place in the region and much of agricultural practices are fully dependent on the available rainfall. Small scale irrigation activities are however taking place in some parts of the county especially for vegetable growing. This is mainly common during the dry seasons particularly in the semi-arid regions of Nyatike and Kuria districts (Migori County, 2012).

The major cash crops grown in Migori County include: sugar cane, tobacco, cassava, and ground nuts. Sugar cane is mainly grown in Awendo, parts of Uriri and Rongo districts while cassava, ground nuts and tobacco are mainly grown in Uriri district, especially around Kanyamkago area and most parts of Kuria district. Ground nuts are also grown in Nyatike as a major cash crop for

small scale farmers. Other crops such as maize, rice, vegetables, and cow peas among others are mainly grown for subsistence purposes across the County. Maize is grown in all parts of the County mainly for subsistence purposes with excess sold for commercial gain (Migori County Development Plan, 2013).

Livestock keeping is also one of the major economic activities taking place in Migori County especially in Kuria and Nyatike districts. Most people in these districts keep local breeds mainly for subsistence use. The Kuria community has a traditional allegiance to animals keeping hence their prominence with livestock. They mostly live a semi-nomadic lifestyle, keeping large herds of animals mainly for prestige. In Kuria, livestock keeping fulfils both economic and social gaps besides crop growing. Other groups of people living within the County keep livestock mainly for subsistence reasons. Cattle, goats, sheep, and donkeys are the most common animals kept by most farmers in the district. Besides animals, birds such as chicken, turkey, geese, etc are also kept by various farmers within the county (Migori County Development Plan, 2013).

Kuria West Sub-county is the southernmost Sub-county in Migori County. It borders the Republic of Tanzania to the South, Kuria East Sub-County to the North-East and Migori Sub-County to the North-West. The Sub-County is divided into eight(8) administrative wards namely: Bukira East, Bukira Central/Ikerege, Isibania, Mokerero, Masaba, Tagare, Nyamosense/Komosoko. Gokeharaka/Getambwega (IEBC, 2012). The total population in Kuria West Sub-county is estimated to be 174,253 and comprises of a total area of 316.9 sq. Km. The socio-economic activity in the study area include crop farming, livestock keeping, brick making and sand harvesting along River Hibwa (Kenya National Bureau of Statistics, 2009).

The type of soil in the said study area is loamy soils and black sandy soils. The Sub-county is mostly characterized by undulating slopes ranging from 1% to about 60%. Farmers have adopted Soil Water conservation measures/Agroforestry on their farms but mostly cultural/biological measures, some are purely cultural e.g. ridging (Migori County, 2010). The type of climate is tropical humid with temperature ranges between 17⁰C to 30⁰C with rainfall occurring most part of the year with a maximum in April to May while December to February is usually a dry season (GOK, 2013).

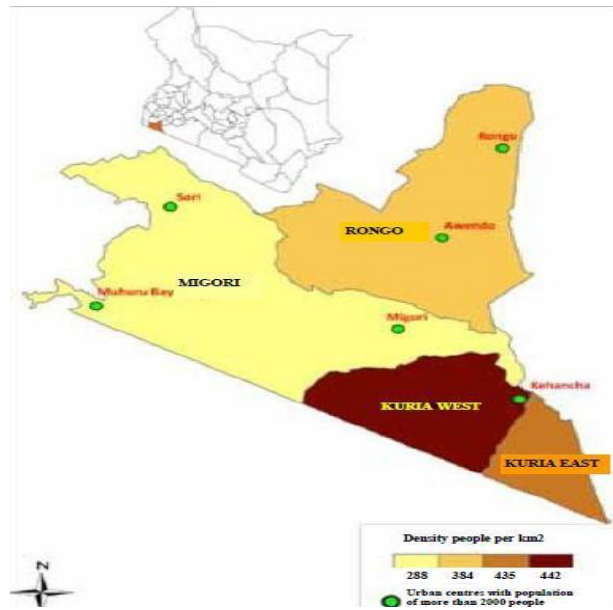


Figure 3.1: A map showing Migori County
Source: Soft Kenya, 2015

**IEBC REVISED KURIA WEST CONSTITUENCY
COUNTY ASSEMBLY WARDS**

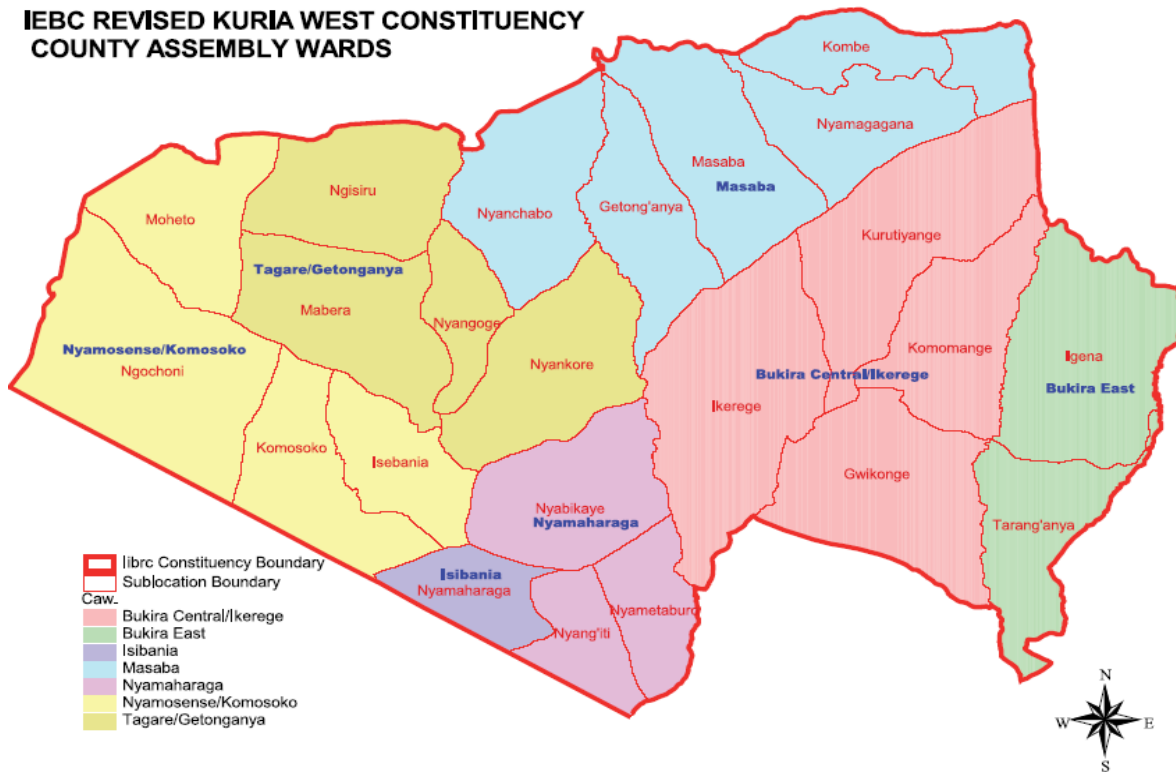


Figure 3.2 A Map showing Kuria West Sub-County
Source: Soft Kenya, 2015

3.3 Research Variables

The main research variables that were considered in the study included: information on Bio-data of the household heads; impacts of tobacco farming to soil and forest with respect to deforestation, reduction of forest cover, disappearance of indigenous trees, reduction in forest resources essential for other uses such as construction and fuel wood etc., soil erosion, soil pollution and infertility. Other variables also included the environmental management practices with respect to crop rotation, strip cropping, cover crops, mulching, zero tillage, revegetation, use of alternative energy and use of energy saving barns/furnaces, among others.

3.4 Sampling Procedures

This study was based on two sub-locations (i.e. Nyametaburo and Ikerege) in Kuria West that are known to be the main tobacco growing zones (Migori County, 2010). However it is important to note that two sub-locations were used for the purpose of getting a representative sample from the target population and not for purposes of comparison. The sampling procedure was purposive sampling where by tobacco farmers were randomly selected from the population. The study targeted only tobacco farmers who have grown tobacco for more than one year from the two sub-locations because of their versed knowledge and experience in tobacco farming. A total of 173 as given by the sample size determination formula were administered to willing tobacco farmer.

Kuria West has a population of tobacco farmers of approximately 4000 (Migori County, 2010) and it was not feasible to do 100% cruises. It was therefore necessary to determine a sample size statistically. Time availability and scope of the study was also put into consideration in determining the sample size. The precision preferred by the researcher was 10% level.

The sample sizes for the two sub locations were determined separately. The formula used was adopted from Yamane (1967:886) and a precision of ten (10%) percent was used. The formula used was as follows; -

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, and e is the level of precision. The number of tobacco farmers in Nyametaburowas estimated to be 750 (Migori County, 2012) therefore the sample size was:

$$n = 750 / (1 + 750(0.1)^2)$$

$$n = 88.235294$$

$$n = 88$$

The number of tobacco farmers in Ekeregewas estimated to be 550 (Migori County, 2012), therefore the sample size was:

$$n = 550 / (1 + 550(0.1)^2)$$

$$n = 84.615384$$

$$n = 85$$

The total sample size was $88 + 85 = 173$; therefore 173 questionnaires were administered to tobacco farmers.

3.5 Data Sources and Methods of data collection

3.5.1 Standardized questionnaire

The main instrument of data collection was a semi structured questionnaire (see appendix 1) on environmental management practices being carried out by tobacco farmers and companies as well as environmental impacts of tobacco farming. The questionnaire was administered by the researcher and two trained research assistants.

3.5.2 Key informant interviewing

This method was used on people who are knowledgeable on environmental management practices as well as impact of tobacco farming to the environment and they included the Sub-county Forest Officer and two field officers. The interviews assisted in exploring in-depth the environmental management practices that are being carried out by tobacco farmers in the study area as well as the impact of tobacco in the area.

3.5.3 Participants observation and Photography

Observation and photographs taking was part of the research exercise. Observation and recording of the management activities amongst tobacco farmers such as reforestation, soil management

activities (e.g. building of terraces, mulching, crop cover, strip cropping etc.) were very essential in this study to bring out a clear picture of the state of the environment in the tobacco growing zones in the study area.

3.5.4 Secondary sources of data

The researcher used documental review to collect secondary data from Ministry of environment and natural resources management, Ministry of Agriculture, Ministry of environment and Ministry of planning, National development in Kuria West Sub-county, SEKU (Tobacco to bamboo research project website: <http://www.tobaccotobamboo.org>) and other relevant sources of data. The sources of data included, textbooks, journals, and project implementation documents, technical reports and publications on the environmental status and environmental management activities on-going in Kuria West Sub-county with interest in tobacco growing areas. This enabled the researcher to get a better insight of the issue under research.

3.5.5 Pretesting of the questionnaire

Pretesting of the questionnaire was carried out to identify questions that don't make sense to participants, or problems with the questionnaire that might lead to biased answers. Twenty-five questionnaires were administered for pre-testing in the study area.

3.5.6 Reconnaissance survey

A reconnaissance survey was conducted before embarking on the main study. The main purpose of the reconnaissance survey was to familiarize the researcher with the area of study as well as get to know and identify the people who participated in the key informant interviews.

3.5.7 Data Analysis, Interpretation and Presentation

Questionnaires and interviews were edited and keyed into the SPSS and Excel computer programme for analysis. Quantitative data was processed and analysed using descriptive statistics such as means and percentages and their results were presented in bar graphs, pie charts and tables. The qualitative data was analysed by first coding and organizing the data into categories then present by use of text and/or graphs.

CHAPTER FOUR

4 RESULTS

4.1 Introduction

The chapter presents findings obtained from the Research. The main instrument of data collection was a questionnaire which contained both open-ended and closed questions, other data collection methods were key informant interviewing, observation, photography and secondary sources of data.

The chapter covers: -

- Socioeconomic characteristics of the households in the study area
- The impacts of tobacco farming to soil and forest resources,
- Environmental management practices being practiced by tobacco farmers and
- Environmental management practices by tobacco companies.

4.2 Socio-economic characteristics

4.2.1 Gender of household head

There were more male household heads (69%) than female (31%) of the respondents interviewed as shown in figure 4.1.

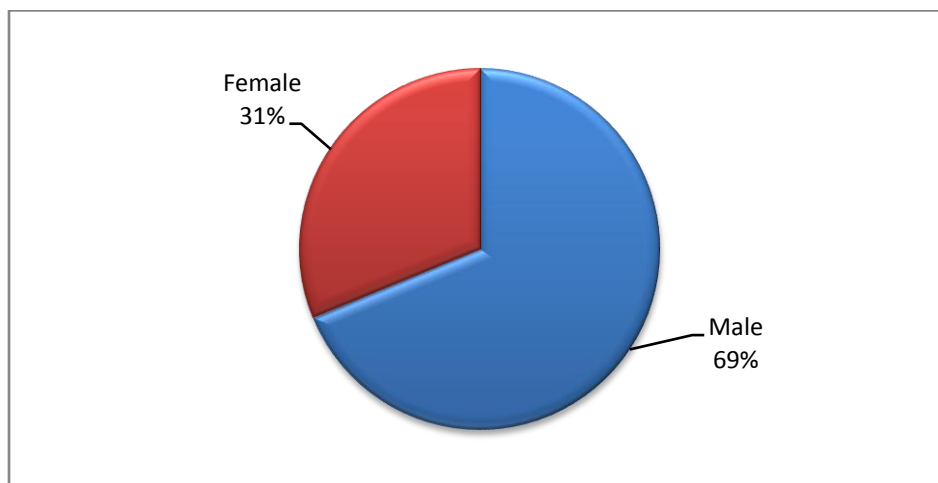


Figure 4.1: Percentages of household heads in the study area.

4.2.2 Age of Household Heads in the study area

From the results of the study it was revealed that the ages of the household head who were tobacco farmers were distributed between the ages of 20 to 69 (Figure 4.2). The 30-39 age group represented the highest number of tobacco farmers (40%), followed by the 20-29 age brackets (39%), then the 40-49 (19%) and 60-69 (2%).

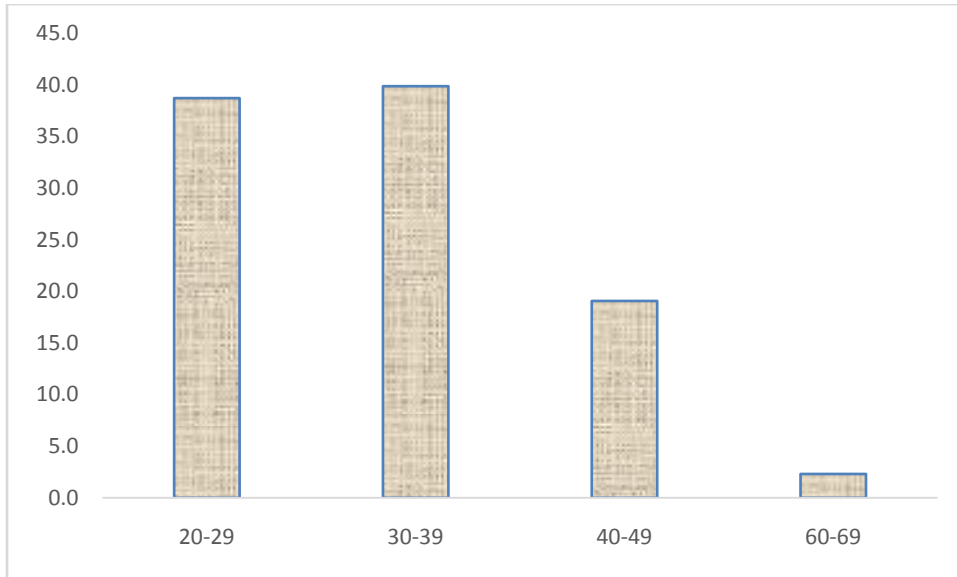


Figure 4.2: Age of Household Heads in the study area

4.2.3 Marital status of Household Heads in the study area

The marital status of the household head within the study area is distributed from married to divorced as shown in the figure 4.3below. The married made up 142 respondents representing 82 %, the singles added up to 26 making up 15% of the respondents, the widowed were 3 representing 2% while the divorced were only 2 making up 1 % of the respondents.

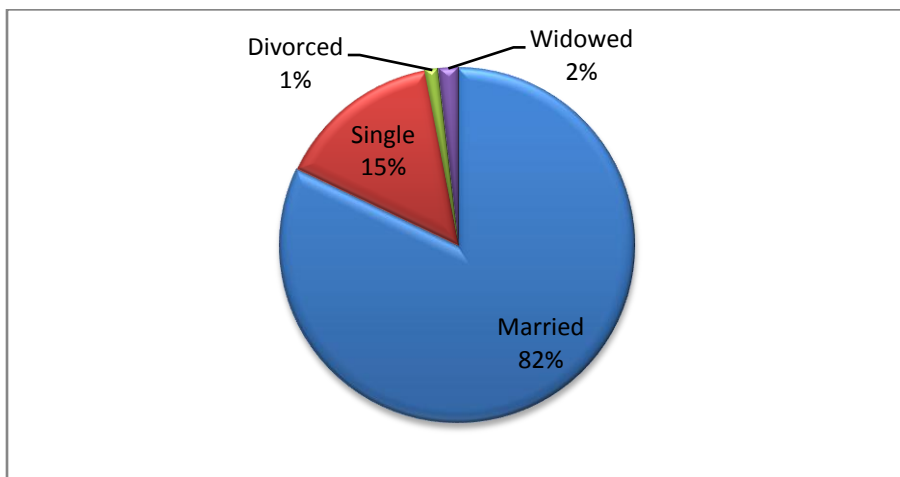


Figure 4.3: Marital status of Household Heads in the study area

4.2.4 Education level of the household Heads

From the study, it was noted that majority of the tobacco farmers were primary school leavers making up 108 respondents (63%), secondary level with 29 respondents (10%), university/college level had 18 respondents (10%) while those who never went to school had 18 respondents (10%) as shown in the figure 4.4below.

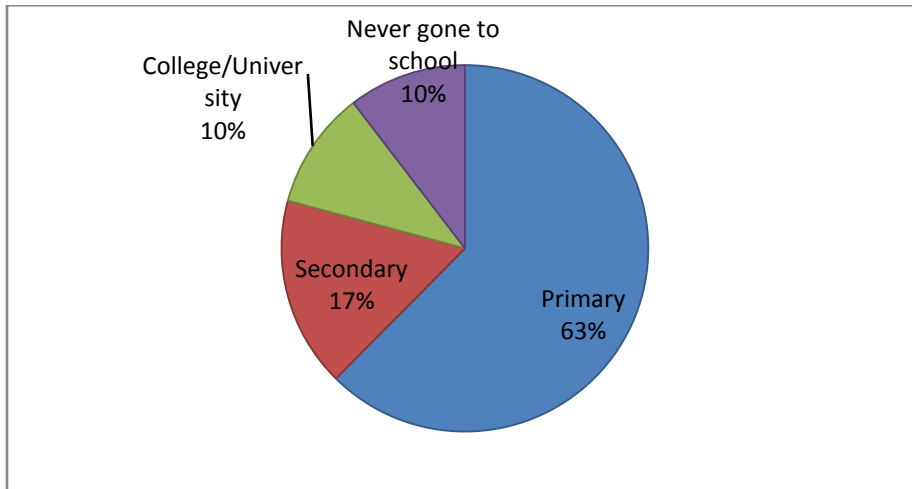


Figure 4.4: Education level of the household Head

4.2.5 Number of years for farming tobacco

From the results of the study it was revealed that the numbers of years tobacco farmers had grown tobacco were distributed between 1 to more than 15 years as shown in the Table 4.1. Those who had been involved in tobacco farming between 7-9years made up 26%, between 4-6years (25%), 10-12 years (15%) between 1-3 (14%), between 13-15 years were 6%, and more than15 years were 13%. One percent did not respond because they were not sure when they started tobacco farming. The study indicates that more than 62% of tobacco farmers have grown tobacco for more than five years and this shows that the tobacco farmers interviewed had ample experience in tobacco farming.

Table 4.1: Number of years of farming tobacco

No of years	Frequency	Percent(%)
1-3	24	13.9
4-6	43	24.9
7-9	45	26.0
10-12	26	15.0
13-15	10	5.8
More than 15 years	23	13.3
No Response	2	1.2
Total	173	100.0

4.2.6 Acreage of land under tobacco farming

Figure 4.5 shows that 53% of the farmers had 0-2 acre of land under tobacco farming, 24% had 3-5 acres of land under tobacco farming, 20% had put 6-8 acres of land under tobacco production and 3% had more than 10 acres of land under tobacco production.

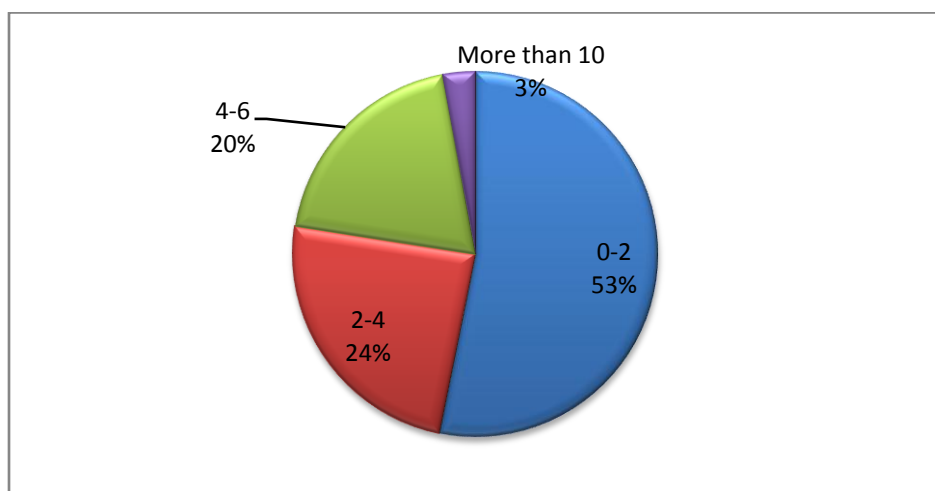


Figure 4.5: Acre of land under tobacco farming

4.2.7 Crops grown by tobacco farmers other than tobacco

Majority of the tobacco farmers (88%) grew maize, 4% grew beans, 3% produced sweet potatoes, 2% cultivated millet, 2% grew vegetables and tomatoes, 1% produced sorghum while 1% grew cassava as shown in the table 4.2 below.

Table 4.2: Crops grown by tobacco farmers other than tobacco

Crops	Frequency	Percent (%)
Maize	152	87.9
Beans	6	3.5
Millet	4	2.3
Cassava	1	0.6
Sorghum	2	1.2
Sweet Potatoes	5	2.9
Vegetables and Tomatoes	3	1.6
Total	173	100.0

4.3 The impacts of tobacco farming to soil and forest resources in Kuria West Sub-county

4.3.1 Pesticides use

The study established that different types of pesticides were used to control pests in a tobacco plantation. The most preferred by farmers was a brand called confidor 200 SL which was used by 72% respondents while another brand called Starthene Rs 700 had 8% of the respondents. Copper and orthene insecticide both had 5% respondents, 4% of the respondents did not respond because they were not aware of the type of pesticide they were using. Bulldock had 3% of respondents, offshoot 2% and thunder 2.5 EC had the least respondents with only 1% of the farmers using it.

Table 4.3: Type of pesticides used by farmers

Type of pesticide	Frequency	Percent (%)
Confidor 200 SL	125	72.3
Starthene Rs. 700	14	8.1
Copper pesticides	8	4.6
Thunder 2.5 EC	2	1.2
Bulldock 25 EC	5	2.9
Offshoot	4	2.3
Ortheneinsecticide	8	4.6
No Response	7	4.0
Total	173	100.0

Table 4.4: Bags of pesticides used per acre

Bags (5kgs) of pesticides applied per acre	Frequency	Percent(%)
1-2	24	13.9
3-4	30	17.3
5-6	36	20.8
7-8	21	12.1
Above 8	55	31.8
I dont apply	1	.6
No Response	6	3.5
Total	173	100.0

From the respondents, per acre, 32% used above 8 bags of pesticide, 21% applied between 5-6 bags, 17% applied 3-4 bags, 14% used 1-2 bags of pesticide while 12% used 7-8 bags of

pesticide. There was no response from 4% of the respondents while 1% affirmed that they did not apply pesticide on their tobacco farms.

4.3.2 Fertilizer use

All the respondents pointed out that they applied fertilizer on their tobacco plantation as shown in figure 4.6 below. Eighty four percent (84%) of the respondents used calcium Nitrate, 8% used Ammonium nitrate, and 7% percent applied Potassium Nitrate while only 1% applied Diammonium Phosphate.

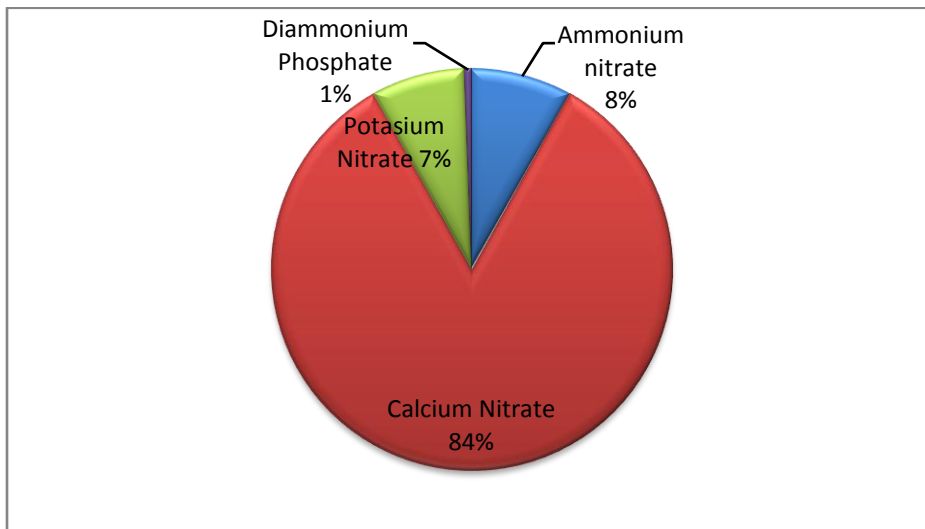


Figure 4.6: Type of fertilizers used by farmers

Table 4.6 shown below shows the number of bags of fertilizer farmers applied per acre. Most farmers applied 5-6 bags making up 49% of the respondents, 3-4 bags had 21% respondents, 7-8 bags had 12% respondents, and 10% respondents applied 1-2 bags of fertilizers while at least 6% applied above 8 bags.

Table 4.5: Number of bags of fertilizer applied per acre in a tobacco farm

Bags (50kgs) of fertilizers applied per acre	Frequency	Percent(%)
1-2	17	9.8
3-4	36	20.8
5-6	85	49.1
7-8	20	11.6
Above 8	10	5.8
I do not apply	2	1.2
No Response	3	1.7
Total	173	100.0

When asked if they sought for technical advice before applying agrochemicals, 72% of the farmers as indicated that they did not seek for technical advice before settling on the amount of fertilizer and pesticide they apply on their farm (Figure 4.7). Of the respondent, 12% sought for advice when they got a chance to, 11% sought for advice before applying agrochemicals, others which represents for percent were not sure if they sought for advice while 1% did not respond.

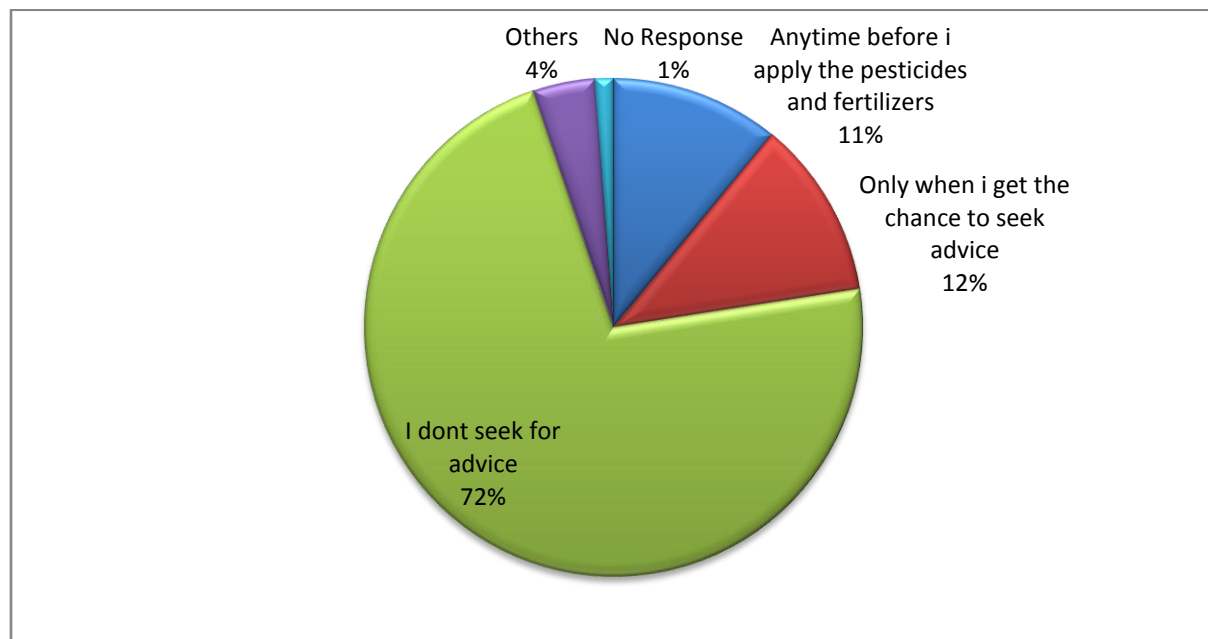


Figure 4.7: Number of farmers who seek for advice before applying fertilizers and pesticides

4.3.3 Tobacco farming and soil fertility

To determine the physical characteristics of the soils where tobacco was grown after harvesting, most farmers in the study area (60%) indicated that the soil became rough/gritty giving it a sandy texture, 28% did not observe any change, 6% observed a very smooth texture while 5% said soils could not hold water for a long time.

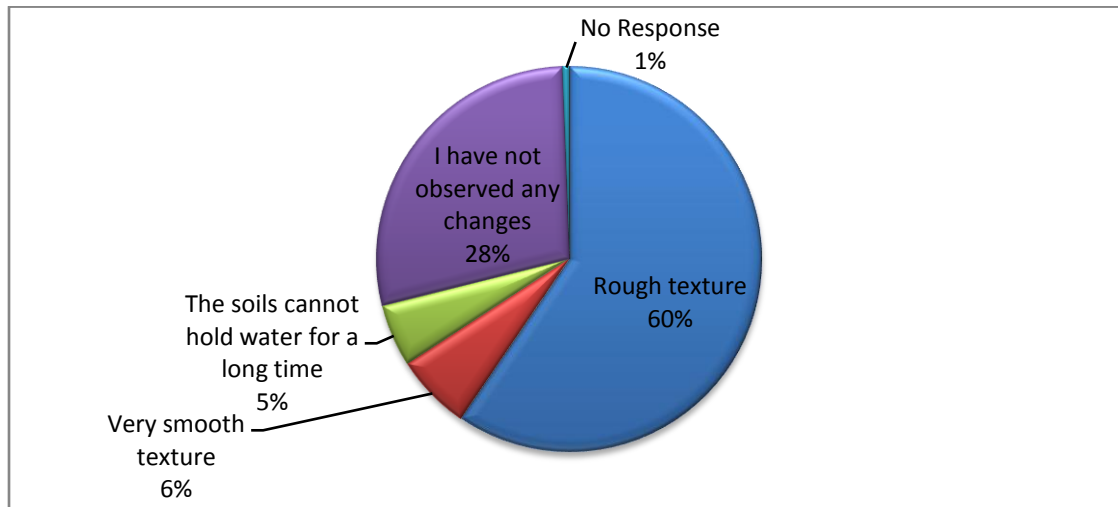


Figure 4.8: Physical characteristics of soils where tobacco was grown

Farmers were also interviewed on how repeated cultivation had affected soil fertility in their farms. As shown in table 4.6 below, the highest number of tobacco farmers (68%) indicated that tobacco farming had led to low crop production, (28%) stated that tobacco production had not affected soil fertility in their farms while 9% said it had led to soil erosion. 2% complained of soil pollution in their farms due to excessive fertilizer and pesticides application, 2% of the respondents did not respond because they were not sure how tobacco had affected soil fertility in their farms while 2% (others) stated that tobacco had led to pests and diseases infestation and crops such as beans were not doing well.

Table 4.6: Effects of tobacco farming on soil fertility

Effects of tobacco farming on soil fertility	Frequency	Percent(%)
It has led to soil erosion	16	9.2
Low crop production	118	68.2
Soil pollution due to excessive fertilizer and pesticide use	4	2.3
It has not affected soil fertility in my farm in anyway	28	16.2
Others	3	1.7
No Response	4	2.3
Total	173	100.0

4.3.4 Soil erosion and tobacco farming

As indicated in Table 4.7 below most farmers indicated that soil erosion in the study area was a result of cutting down of trees for curing tobacco as per 90% of the respondents. A few respondents (5%) could not explain the cause of soil erosion in their farms while 3% of the respondents explained that intensive tobacco cultivation is responsible for soil erosion. Of the respondents, 1% did not respond to the question while 1% acknowledged that cultivation of tobacco in the fragile land had led to soil erosion.

Table 4.7: Causes of soil erosion in the study area

Causes of soil erosion	Frequency	Percent(%)
Cutting down of trees to cure tobacco	155	89.6
Cultivation of tobacco in the fragile lands e.g. at the steep slope, river banks etc.	1	.6
Intensive tobacco cultivation	6	3.5
I don't know	8	4.6
No Response	3	1.7
Total	173	100.0

From figure 4.9, soil erosion removes topsoil that is rich in crop nutrients and organic matter resulting in low soil fertility and this account for the 45% of the respondents. Consequently, low soil fertility leads to low crop production and this explains the 51% of the respondents. Soil erosion had also led to high cost of production at 3% while 1% of the respondents did not respond.

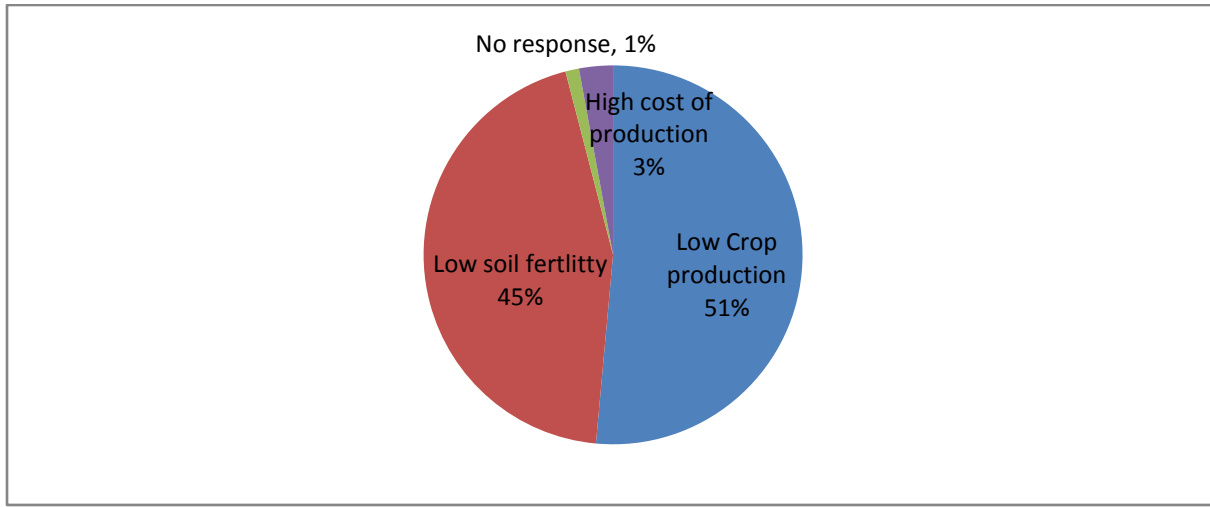


Figure 4.9: Effects of soil erosion caused by tobacco farming

4.3.5 Tobacco farming and deforestation

From the study, 62% of the respondents cut down trees during tobacco seasons for curing tobacco, 20% used wood for constructing barns while 17% cut down trees to get poles and sticks for preparing tobacco leaves for cure.

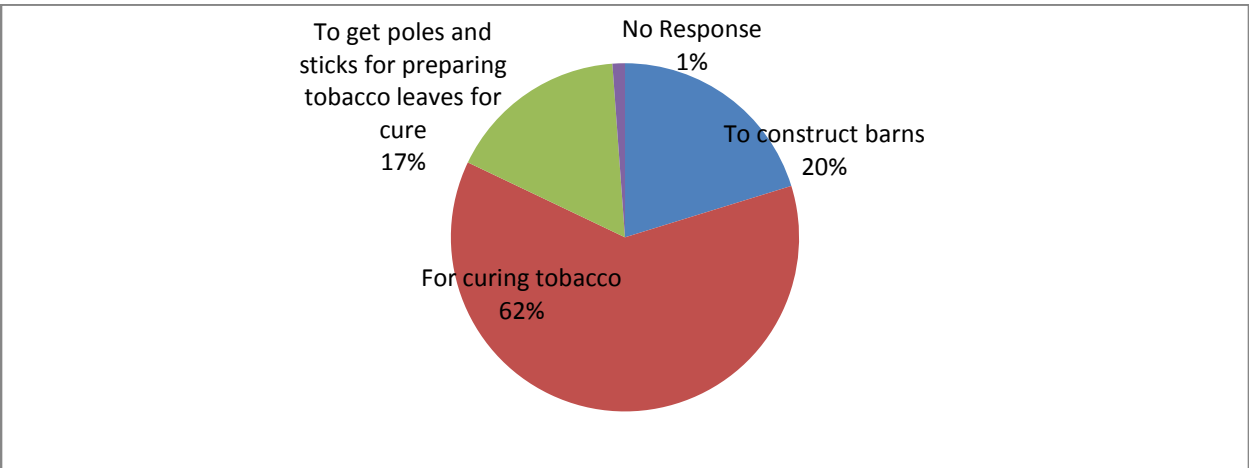
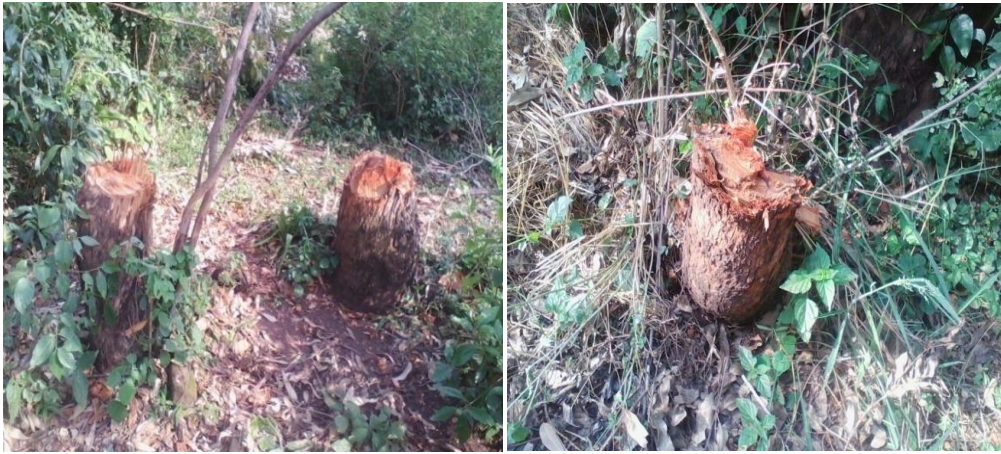


Figure 4.10: Reasons for cutting down trees during tobacco season

At the tobacco farmers’ farms, several stumps of trees and logs of wood were observed. Tobacco farmers confirmed that the trees (both indigenous and exotic) had been cut down to cure tobacco leaves (See plate 4.1, 4.2 and 4.3 below).





***Plate 4.1: Stumps of trees cut down for tobacco curing at a tobacco farmer's land in Ikerege
Photo taken by: Lydia Boke (author) Date: 15.4.2014***



***Plate 4.2: Logs of wood outside two tobacco farmers' compounds for curing tobacco in Ikerege
Photo taken by: Lydia Boke (Author) Date: 15.4.2014***



Plate 4.3: Logs of wood outside two tobacco farmers' compounds for curing tobacco at Ikerege
Photo taken by: Lydia Boke Date: 15.4.2014

The figure 4.11 below show the type of curing that is used by tobacco farmers. 97% of the respondents used flue-curing, 2% of the respondents used twigs and leaves while 1% of the respondents did not respond.

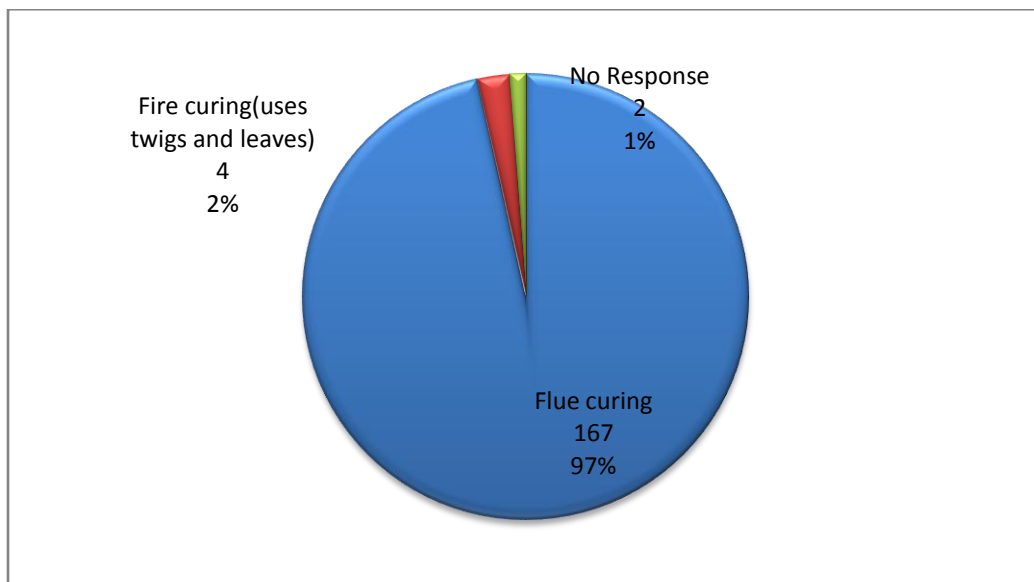


Figure 4.11: Type of curing that is used by tobacco farmers

The table 4.8 below illustrates where most tobacco farmers got their wood from for curing tobacco. Fifty seven percent (57%) bought wood, 27% obtained from a forest, 7% got from a neighbour for free, 6% got from tobacco companies on loan, 2% got wood from their own woodlot while 1% did not want to reveal the source of their wood for curing tobacco.

Table 4.8: Source of wood for curing tobacco

Source of wood	Frequency	Percent (%)
From a forest	47	27.2
From my woodlot	3	1.7
From a neighbour	12	6.9
I buy	99	57.2
From tobacco companies	10	5.8
No Response	2	1.2
Total	173	100.0

When interviewed on the number of mature trees farmers used for curing tobacco, 39% used between 6-10 mature trees, 17% used more than 20 mature trees for one season, 15% used between 1-5 and 16-20 each, 14% used between 11-15 mature trees while 1% did not respond because they were not sure how many trees they consumed per season as shown in table 4.9 below.

Table 4.9: Number of mature trees used for curing tobacco for one season

No. of mature trees used for curing tobacco in one season	Frequency	Percent (%)
1-5	25	14.5
6-10	68	39.3
11-15	24	13.9
16-20	25	14.5
More than 20	29	16.8
No Response	2	1.2
Total	173	100.0

4.3.6 Tobacco farming and biodiversity loss

From the study, 95% of the respondents said the indigenous tree cover had reduced over the 20 years while 2% said it had increased while 1% said there was no difference.

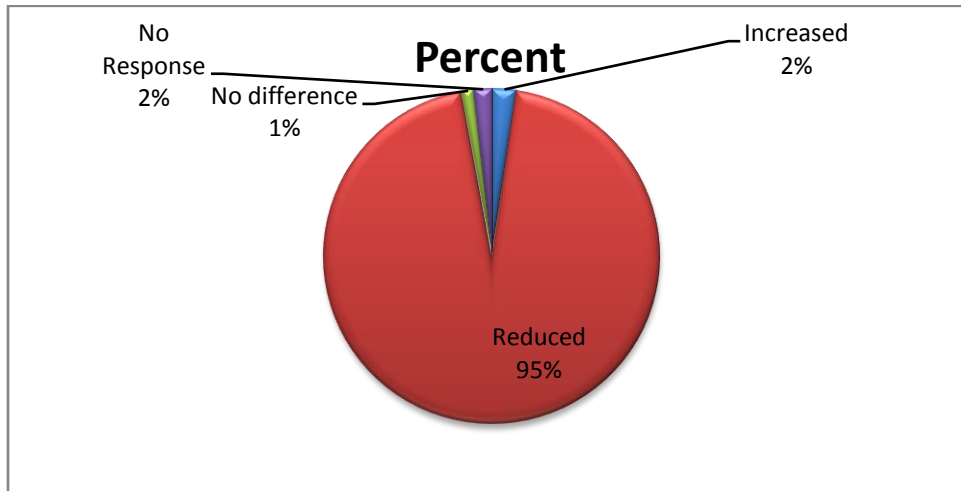


Figure 4.12: Status of the indigenous tree species for the past 20 years

The highest percentage (60%) of the respondents acknowledged that the indigenous forest cover reduction was due to tobacco curing as explained in figure 4.13. 35% attributed the disappearance of the indigenous trees to construction of mainly curing barns, houses among others, 3% of the respondents indicated that the wood for indigenous trees was used for making furniture while 2% of the respondents could not account for the disappearance of the indigenous trees. However, a few indigenous trees were observed at the tobacco farmers compound (See plate 4.4 below).

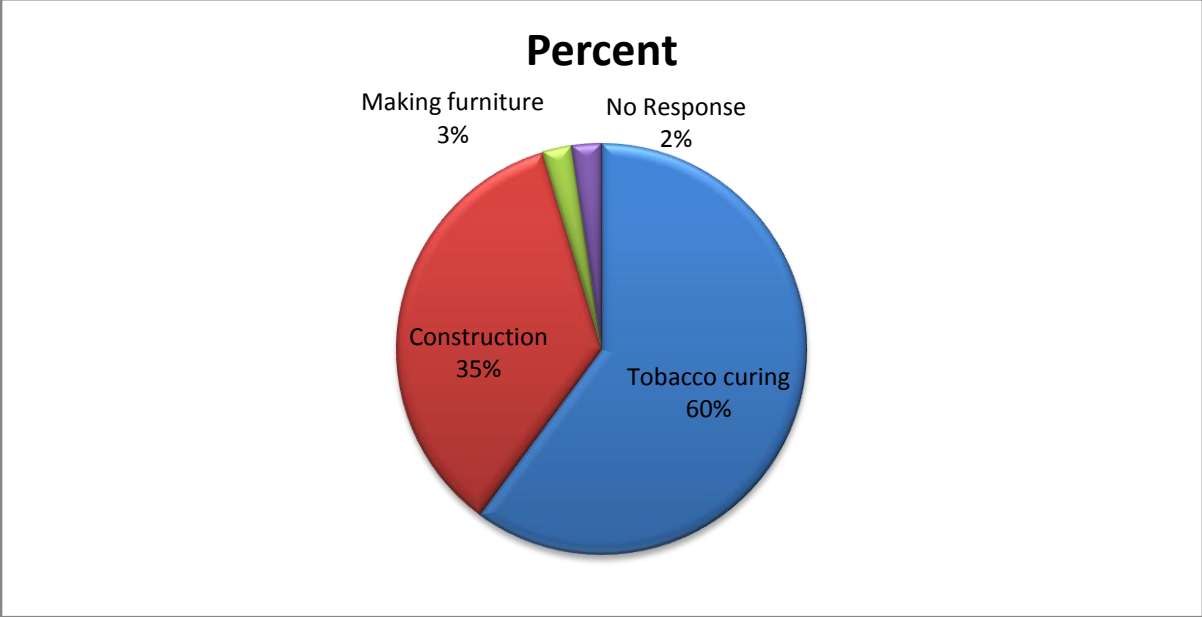


Figure 4.13: Reasons for the disappearance of the indigenous tree species



1.



2.



3.

4.

Plate 4.4: Shows: 1. *Kigelia africana*, 2. *Ficus sycomorus*, 3. *Syzygium aromaticum*, 4. *Acrocarpus fraxinifolius*, a few remaining indigenous species in the study area

Photo taken by: Lydia Boke Date: 15.4.2014

During the survey, tobacco farmers were interviewed on the initiatives they put in place to ensure the indigenous tree species and wildlife in general are not endangered or threatened by extinction by the deforestation. Their responses are shown in the table 4.10 below. From the responses, 86% of the respondents absolutely did nothing to protect the endangered species. Only 6% of the respondents sought for permission from KFS before cutting down indigenous species. 5% carried out reforestation initiative and only 1% did not cut down indigenous species as an initiative to protect the endangered species.

Table 4.10: Initiatives by tobacco farmers to prevent cutting down of indigenous species

Initiatives to prevent cutting down of indigenous trees	Frequency	Percent
By not cutting them down	2	1.2
By seeking for permit from the forestry offices before cutting them down	11	6.4
Through afforestation/reforestation	9	5.2
I do nothing	149	86.2
No Response	2	1.2
Total	173	100.0

Farmers identified the species that had disappeared over time in the study area due to tobacco cultivation as shown in the figure 4.14 below.

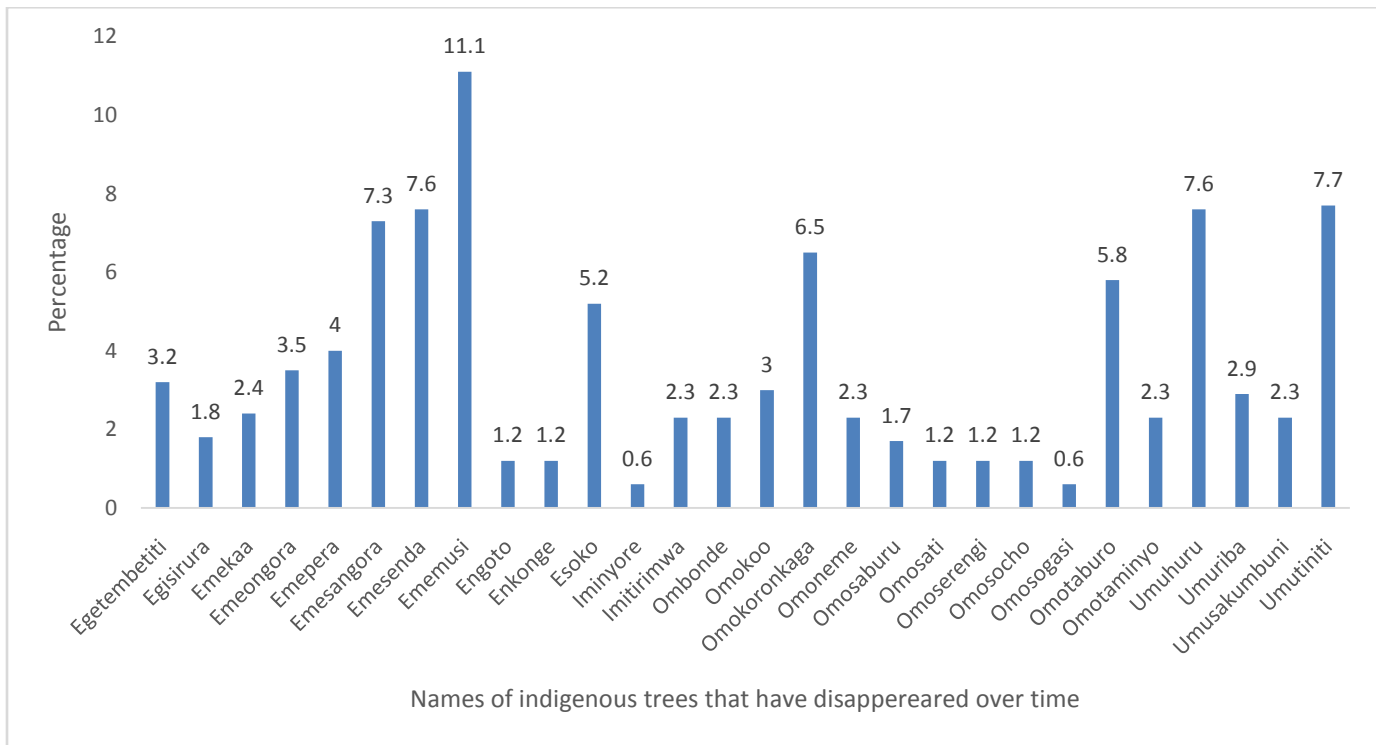


Figure 4.14: Indigenous species that have disappeared over time in the study area. Names given in Kuria language.

4.4 Environmental management practices being carried out by tobacco farmers

Tobacco growing has been known to cause widespread environmental, social, economic and health problems. Tobacco cultivation is responsible for the extensive deforestation and soil degradation that has been witnessed in tobacco growing zones. This section shows the findings of the study on the environmental management practices being carried out by tobacco farmers in the study area with an aim to reduce deforestation and soil degradation in the study area. Some of the environmental management practices that were exploited in this section include soil management practices such as crop rotation, strip cropping, mulching, zero tillage and cover crops etc. Other environmental management practices that were examined were reforestation/afforestation initiatives, use of alternative energy and energy saving barns/furnaces among others.

4.4.1 Environmental management practices by farmers to control soil degradation

4.4.1.1 Soil Management Practices

When interviewed on environmental management practices in place to control soil degradation, 94% of the respondents pointed out that they practised crop rotation, 4 % did not respond while only 1% did revegetation as a soil management practice.

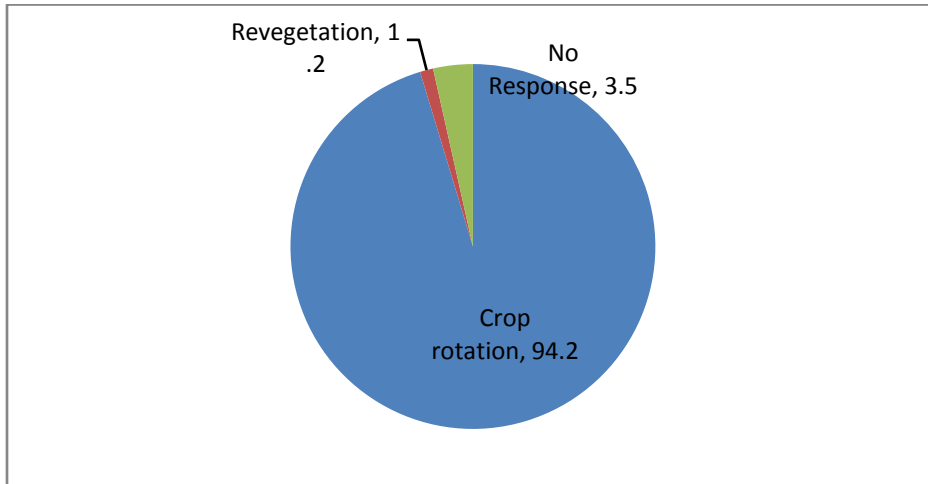


Figure 4.15: Soil management practices

It was evident that most farmers preferred to rotate tobacco with maize with 65% respondents compared to other crops as shown in figure 4.16 below. Beans had 31% respondents while sorghum had 3% respondents while 1% did not respond.

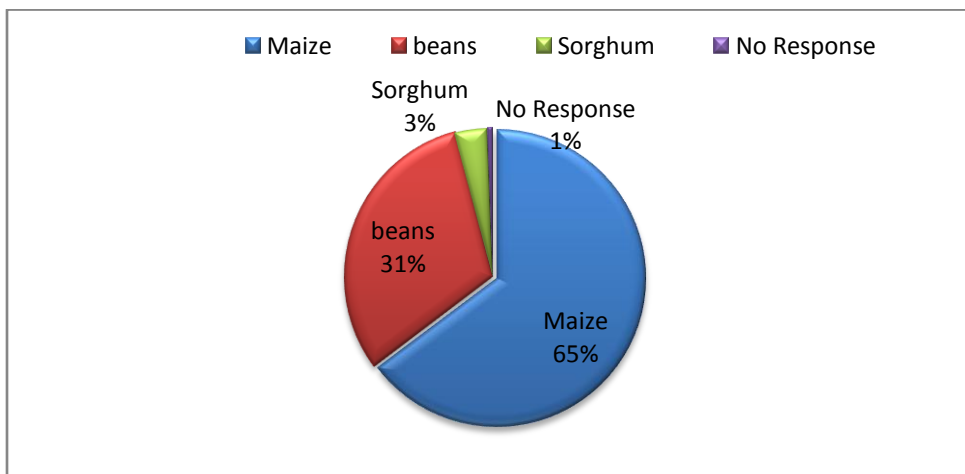


Figure 4.16: Crops rotated with tobacco

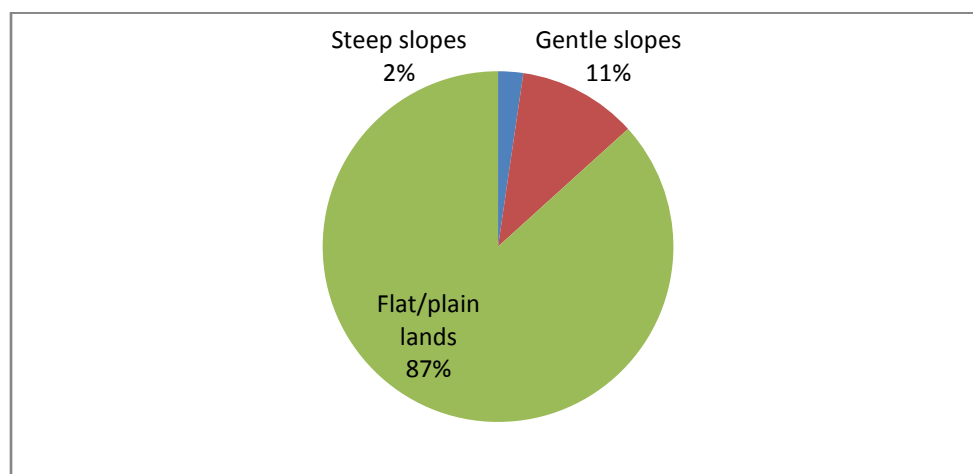


Figure 4.17: Other initiative to control soil erosion

When interviewed on other initiatives being employed by farmers to control soil erosion, 87% of the respondents grew tobacco on flat/plain lands, 11% grew tobacco on gentle slope while 2% cultivated on steep slopes.

4.4.2 Reforestation

During the survey, tobacco farmers admitted that tobacco farming involves cutting down of massive numbers of trees per season and the only way to ensure the forest resources are not depleted and erosion does not get out of control is by restocking the existing forests. From the study 53% of the respondents planted *Eucalyptusspp* after cutting down trees for curing tobacco, 24% of the respondents planted *Cupressusspp.*, *Grevillea robusta* had 16% respondents, *Jacarandaspp* had 5% while *Oleaafricana* had 2% respondents.

Table 4.11: Plant species used for reforestation

Species	Frequency	Percent (%)
<i>Cupressusspp</i>	41	23.7
<i>Eucalyptusspp</i>	93	53.8
<i>Grevillea robusta</i>	27	15.6
<i>Jacarandaspp</i>	8	4.6
<i>Oleaafricana</i>	4	2.3
Total	173	100.0

During the interview, farmers were asked whether the seedlings they used for reforestation were certified by KEFRI, of the respondents (64%) said they do not know and 35% believed the seedlings were not certified as they were sourced locally, while 1% did not respond.

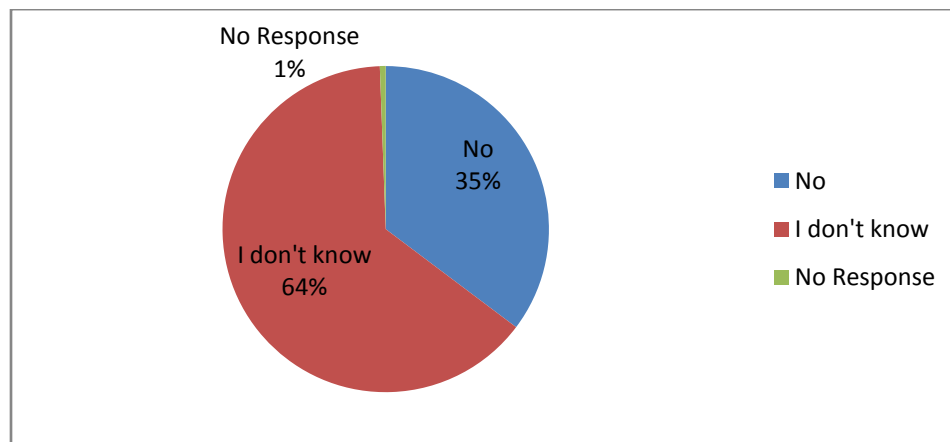


Figure 4.18: Certification of the seedlings by KEFRI

4.4.3 Alternative sources of energy for curing tobacco

Farmers were interviewed on available alternative sources of energy for curing tobacco, 95% of the respondents said there was no other alternative for curing tobacco other than wood while 5% said they used twigs and leaves from trees (Table 4.12).

Table 4.12: Alternative sources of energy for curing tobacco other than wood

Alternative sources of energy	Frequency	Percent (%)
using twigs and leaves only	9	5.2
There is no other alternative other than wood	164	94.8
Total	173	100.0

4.4.4 Type of barn used for curing tobacco

Table 4.13: Type of barn used for curing tobacco

Type of barn	Frequency	Percent (%)
Improved barn/furnace	38	22.0
Traditional barn (Non-energy saving)	135	78.0
Total	173	100.0

Farmers were interviewed about the type of barn they use to cure tobacco. From table 4.13 above, 78% of the respondents used traditional/conventional barn(Plate 4.6) to cure tobacco while 22% used improved barns with well insulated walls (Plate 4.7).



*Plate 4.5 A traditional barn outside a tobacco farmer's homestead
Photo taken by: Lydia Boke Date: 15.4.2014*



4.4.5 Initiatives by farmers to minimize excessive use of wood

The researcher explored the various initiatives being carried out by farmers to minimize excessive use of wood. Eighty six(86) of the respondents that made up 50% harvest only ripe tobacco leaves (See plate 4.8)that required less curing, 53 of the respondents constituting 31% re-used wood in construction of curing barns, 18 of the respondents adding up to 10% used improved barns while 7 respondents that made up 4% do nothing to minimize excessive use wood.

Table 4.14: Initiatives by tobacco farmers to minimize use of wood

Initiatives by tobacco farmers to minimize use of excessive wood fuel	Frequency	Percent (%)
<i>Photo taken by: Lydia Boke Date: 15.4.2014</i>		
Using improved barns	18	10
Reusing wood in construction of curing barns	62	36
Harvesting only ripe tobacco which needs less curing	86	50
None	7	4
Total	173	100.0



Plate 4.7: Ripe tobacco leaves ready for curing

4.4.6 Initiatives by tobacco farmers to prevent cutting down of indigenous trees species

Table 4.15: Initiatives by tobacco farmers to prevent cutting down of indigenous trees species

Tobacco farmers' initiative	Frequency	Percent (%)
Planting exotic trees for curing tobacco	135	78.0
Using other alternative for curing tobacco other than wood	6	3.5
I have done nothing	32	18.5
Total	173	100.0

On initiatives by tobacco farmers to prevent cutting down of indigenous trees (table 4.15), 78% of the respondents planted exotic trees for curing tobacco as a substitute for indigenous trees. The most preferred species in the study area as shown in table 4.11 was Eucalyptus as advised by tobacco companies because of their fast growth and their ability to grow in any condition. Of the

respondents, 19% absolutely did nothing to prevent cutting down of indigenous trees because of their ability to burn for a long time in the tobacco furnace producing good quality tobacco leaves. Only 4% used other alternatives for curing tobacco other than wood from indigenous tree and this include use of leaves and twigs cut from exotic trees.

4.5 Environmental management practices by tobacco companies

Apart from exploring the initiatives being carried out by farmers to conserve soil and forest resources, the researcher also surveyed the efforts in place by tobacco companies who are the major stakeholders to safeguard soil and forest resources. Some of the initiatives that were explored in this section include reforestation, soil management practices, technical advice/education/training, promotion of use of alternative energy and energy saving barns/furnaces among others.

4.5.1 Sensitization on environmental management practices by tobacco companies

Majority of the farmers at 66% had been sensitized on the importance of tree planting while 28% had not been sensitized on any environmental management practice (table 4.16). Four percent (4%) had been encouraged to practice sustainable agriculture whereas 1% said they had been encouraged to use improved barns and the 1% under ‘others’ included soil management practices such as use of crop rotation.

Table 4.16: Sensitization on environmental management practices by tobacco companies

Environmental management practices	Frequency	Percent (%)
Tree planting	114	65.9
On sustainable agriculture	7	4.0
Use of improved barns	2	1.2
Others(specify)	2	1.2
None	48	27.7
Total	173	100.0

4.5.2 Trees Species planted by farmers as an initiative by tobacco companies to promote afforestation/reforestation

Table 4.17 Tree species promoted by tobacco companies for afforestation/reforestation

Tree species promoted by tobacco companies	Frequency	Percent (%)
<i>Cupressus</i> spp	28	16.2
<i>Eucalyptus</i> spp	79	45.6
<i>Grevillea</i> robusta	34	19.7
<i>Jacaranda</i> spp	1	.6
None	31	17.9
Total	173	100.0

The study showed that 46% of the respondents had planted Eucalyptus as an initiative by tobacco companies to promote reforestation, 20% had planted *Grevillea*robusta, 18% said they had not planted trees as a result of tobacco companies' initiative, 16% had planted *Cupressus*spp while 1% had planted *Jacaranda* spp (Table 4.17).

4.5.3 Technical and education training by tobacco companies

On technical and education training being offered by tobacco companies, Figure 4.18 shows that sixty nine percent (69%) of respondents were advised on appropriate use of fertilizers and pesticides, while 26% did not receive any technical advice, 4% had been educated on sustainable soil management while 1% received technical advice on appropriate tree species to be used in afforestation and reforestation.

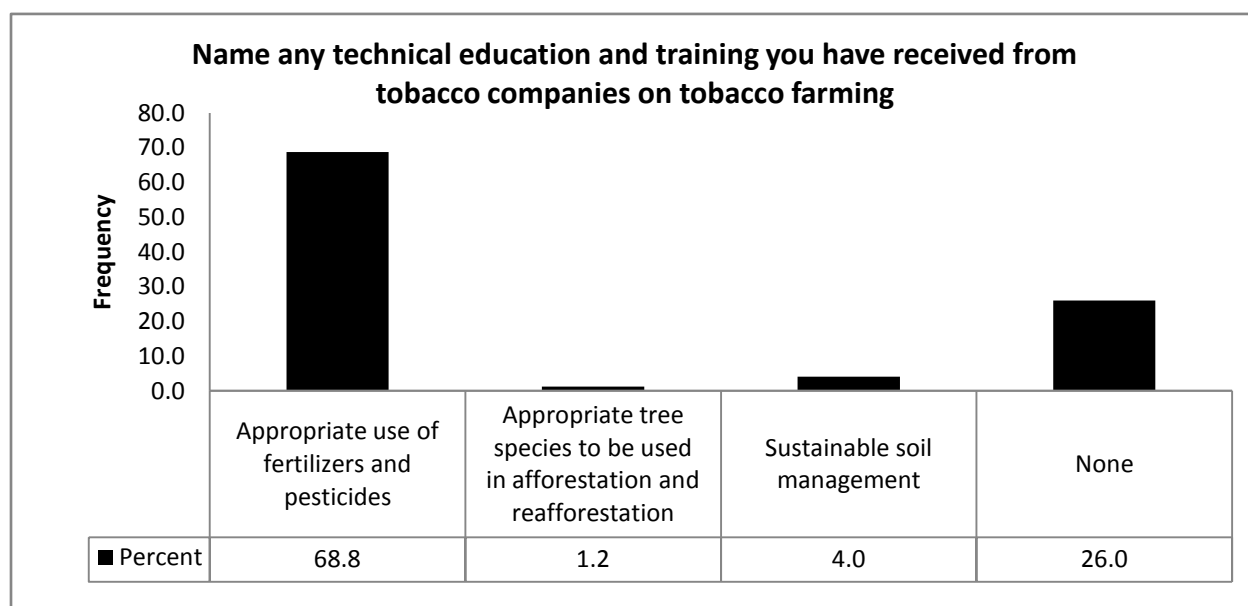


Figure 4.19: Technical education and training by tobacco companies

4.5.4 Alternative Methods of pest control tobacco farmers have been advised to use by tobacco companies over Chemical Pesticides and fertilizers

Table 4.18: Alternative methods to chemical pesticides as advised by tobacco companies

Type of pesticide	Frequency	Percent (%)
Biological control	4	2.3
We have not been advised to use any other type but chemical pesticides	169	97.7
Total	173	100.0

When interviewed on alternative methods used to control pests invasion other than chemical pesticides, (table 4.18) 2% of the respondents said they had been advised by tobacco companies to use biological control method to control pests while 98% of the respondents had not been advised to use any other method to control pests except chemical pesticides.

On fertilizer use, the data collected indicated that 100% of the respondents had not been encouraged to use any fertilizer apart from inorganic based fertilizer for their tobacco crop.

4.5.5 Soil management practices promoted by tobacco companies

Some of the soil management practices include crop rotation, use of cover crops, strip cropping, multiple cropping, zero tillage and re-vegetation. However, from the study, 72% of the respondents said that none of these practices are being promoted by tobacco companies while 28% said that only crop rotation was being encouraged by tobacco companies.

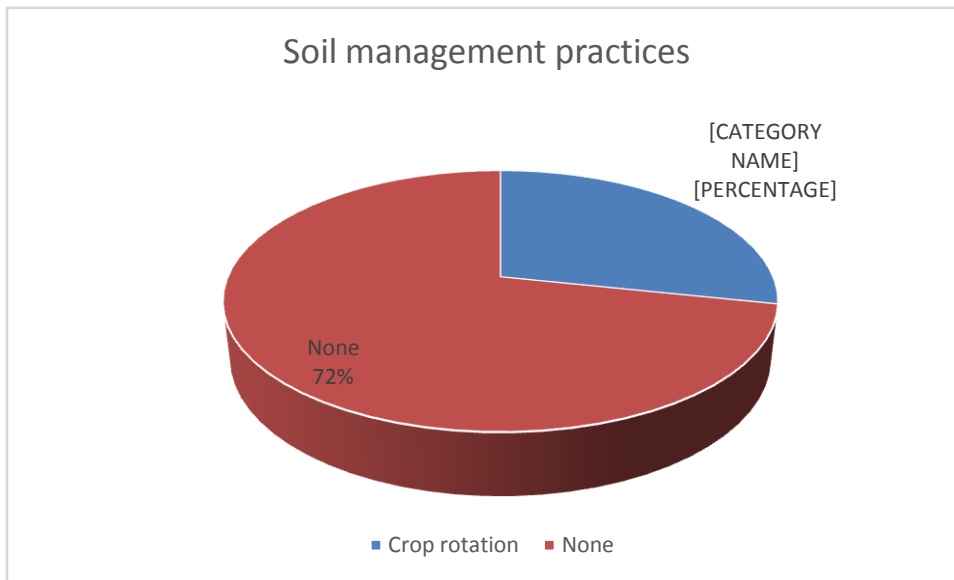


Figure 4.20: Soil management practices promoted by tobacco companies

4.5.6 Alternative sources of energy promoted by tobacco companies other than wood

The survey (table 4.19) showed that 97% of the respondents believed that tobacco companies did not promote alternative source of energy for curing tobacco other than wood, 2% said tobacco companies promoted use of twigs and leaves to cure while 1% held that tobacco companies promoted use of solar energy but none of the farmers used it.

Table 4.19: Alternative sources of energy promoted by tobacco companies

Alternative sources of energy	Frequency	Percent (%)
Solar energy	2	1.2
use twigs and leaves only	3	1.7
None	168	97.1
Total	173	100.0

4.5.7 How tobacco companies minimize use of excessive wood fuel

When interviewed on initiatives tobacco companies had put in place to minimize wood consumption, (39%) of the respondents said that tobacco companies encouraged reuse of wood in construction of curing barn, 24% insisted that tobacco companies promoted use of improved barns, 23% said tobacco companies advised farmers to harvest only ripe tobacco that requires less curing, 15% said nothing had been done by tobacco companies to minimize excessive wood consumption while 6% stated that tobacco companies had encouraged farmers to consider use of bricks in construction of curing barns rather than wood and only 2% said that tobacco companies encouraged farmers to construct curing barns with well insulated walls and barns .

Table 4.20: Strategies by tobacco companies to minimize use of wood energy

Initiatives by tobacco companies to minimize use of excessive wood fuel	Frequency	Percent (%)
By promoting use of improved barns	41	23.7
Ensure tobacco farmers harvest only ripe tobacco which needs less curing	40	23.1
Consider reuse of wood in construction of barns	67	38.7
Encourage farmers to construct curing barns with insulated walls and floors	4	2.3
Encourage farmers to consider use of bricks in construction of curing barns other than trees	6	3.5
Nothing has been done	15	7.5
Total	173	100.0

CHAPTER 5

5 DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter discusses the research findings, gives the conclusions and recommendations of the study. It is divided into three parts, the first part discusses the results, the second gives the conclusions of the study and the third part gives the recommendations that would ensure the soil and forest resources are not degraded because of tobacco farming. The author first reflects on each of the objectives at a time and each of the corresponding research question. On that basis, we make logical recommendations and identify prospects for the future.

5.2 Discussion

5.2.1 Socio-economic characteristics

5.2.1.1 Gender of household head

There were more male household heads than female of the respondents interviewed in the study area. This is in line with the tobacco farmers' population in Kuria West Sub County; where male dominate as opposed to the opposite gender, the social, economic and political status of women in the study area is relatively weak (Kibwage et al, 2014). Previous findings by Kibwage et al (2014) indicate that Kuria is a male dominated society where the men make decision for the household. The few households that were found to be headed by women were majorly the widowed, divorced and single women.

5.2.1.2 Education level of the household Heads

From the study, it was noted that majority of the tobacco farmers were primary school leavers. This collaborate with the study by Chacha et al (2010) whose findings show that the education level in Kuria West Sub-county is still low and the poverty level is high and therefore most pupils drop out of school at primary level due to lack of school fees. Those who drop out of school resort to tobacco farming and this explains why most of the tobacco farmers are primary school leavers. Those in university/college category most of them are employed and have other occupations other than farming.

5.2.1.3 Crops grown by tobacco farmers other than tobacco

The food crops grown in the study area is mainly for subsistence use. Maize is the main staple food in the region and this explains why it was more preferred than other crops. These findings concur with the study by Kibwage et. al. (2014) where crops were ranked based on their subsistence and commercial importance. Maize was at the top of the rank followed by beans. This undoubtedly indicates that apart from tobacco, farmers also grew other crops that are equally important to their livelihood.

5.2.2 The impacts of tobacco farming to soil and forest resources in Kuria West Sub-county

5.2.2.1 Pesticides and fertilizer use

Tobacco plants are prone to pests and diseases; therefore, farmers are compelled to use pesticides to maintain foliage weight and quality and maximize on production. This study established that almost all the respondents applied pesticides on their crops. This concurs with Lecours et al, (2012) findings where he specified that as a monocrop, tobacco crop is susceptible to a variety of pests and diseases, which require the application of large quantities of pesticides.

The pesticides are applied right from the time the crop is in the nursery to when the crop is harvested. These pesticides contain active ingredients which are harmful to the environment and when they are concentrated in the soil, they lead to soil pollution. Confidor 200 SL also known as imidacloprid for instance is a pesticide used to control piercing insects such as aphids and tobacco slug as prescribed on its container (ASH, 2009). There is no clear procedure on how the farmers decided on the number of bags of fertilizers and pesticides applied to tobacco farms as the study indicated. This is because 72% of the farmers did not seek for technical advice before settling on the amount of fertilizer and pesticide they applied on their farms. This kind of practice can be damaging to the physical, chemical and biological status of the soil especially when applied in excess because it can lead to soil pollution and decrease the natural fertility of the soil by killing the soil microorganisms. African Union (2007) study validates this finding by pointing out that pesticide use is less regulated in Low and Medium Income Countries than High Income countries resulting to deleterious environmental health effects. FAO (2011) affirms this by stating that as much as use of inorganic fertilizers leads to considerable increases in overall food production, the

intensive use of these fertilizers leads to a decline in soil organic matter levels and the misuse of these external inputs has far reaching effects such as deterioration of soil quality and reduction in agricultural productivity due to nutrient depletion, organic matter losses, erosion and compaction.

Even though the use of pesticides and fertilizers is well known in Low and Medium Income Countries (LMIC), the details of its use and associated health and environmental impacts are not well known (Lecours et al, 2012). This is anticipated to have a harmful effect to the soil since some insects play an important role in soil aeration hence aiding in soil fertility. Soil pollution which leads to soil degradation is likely to occur due to continuous use of pesticides which contain some harmful components making the soil unproductive.

All the respondents confirmed that they used chemical fertilizer to enhance tobacco production. It is important to note that tobacco is a nutrient demanding crop and it depletes nutrient from the soil at a faster rate compared to other crops (FCTC, 2008). It is no wonder the multinational tobacco firms offer, through loans, huge amounts of farming inputs to support tobacco production (Lecours et al 2012). Loker (2005) in his study noted that amounts of fertilizer use intensify to compensate for soil exhaustion brought on by continuous tobacco farming. Furthermore, tobacco depletes the soil nutrients through their accumulation in the leaves. Harvesting takes away those nutrients instead of allowing the organic matter to decompose to release them back to the soil (FAO,2009). Calcium nitrate was the most preferred amongst tobacco farmers in the study area because it was easily available and contained essential nutrients for the tobacco crop.

5.2.2.2 Tobacco farming and soil fertility

The findings of these study established that most respondents stated that they experienced low crop production as a result of decline of soil fertility. In his study, Tobin and Knausenberger (1998) found that tobacco exhausted more than 10 times as much nitrogen, 24 times as much potassium, and 36 times as much phosphorus as does cassava, even maize with its high nutrient needs depletes the three nutrients substantially less than does tobacco. Owing to tobacco's impacts on soil fertility, farmers are advised not to grow tobacco on the same land more than once every four years (Tobin and Knausenberger, 1998). Such a practice, where tobacco is grown repeatedly in a piece of land results to low crop production (FAO, 2009).

Tobacco extracts nutrients from the soil. That is why after harvesting most farmers in the study area indicated that the soil became rough/gritty giving it a sandy texture. This is an indication of low organic matter content which is responsible for forming soil aggregates which improves soil structure (FAO, 2009). This is attributed to harvesting of tobacco leaves (FAO,2009), where nutrients are usually removed from the soil each time a crop is harvested. Previous studies (Gene, 2001) showed that during the colonial time in USA when tobacco was first introduced in Chesapeake in the 1612, tobacco was known to extremely exhaust the soil. The same study (Gene, 2001) revealed that after three years of being harvested, the tobacco had exhausted the soil of its nutrients, leaving much of the land worn out and of no use to farmers. Gene (2001) notes that Montgomery County for instance, by 1783 much of the land had become a relatively barren landscape thus forcing many people to abandon the farms and settle elsewhere to have any opportunity of succeeding economically.

Lecours et al (2012) points out that specific tobacco farming practices of ‘topping’ and ‘desuckering’, intended to reach high levels of nicotine and high leaf yields, also contribute to the depletion of soil nutrients.

Excessive and often unnecessary use of pesticides and fertilizers is harmful to the soil microbes and consequently interferes with soil fertility. Some of the respondents stated that soil pollution associated with fertilizer and pesticides application also impeded soil fertility leading to low crop production. This concurs with the study by Wilson and Tisdell (2001) whose findings showed that as production and productivity increased with high input use, the level of pollution of pesticides too increased. Furthermore Wilson and Tisdell (2001) indicate that the pollution impacts on production is in the form of declining soil fertility and the proliferation of agricultural pests due to pesticide resistance and the decimation of beneficial predators of pests. The current study has confirmed that crops such as beans and tomatoes did not do well in soils where tobacco was grown due to attack by pests and diseases. This is because tobacco is prone to many pests invasion such as tobacco hornworms, tobacco budworms, flea beetles and cutworms which remain in the soil even after harvesting (Francis and Reay, 2013).

5.2.2.3 Soil erosion and tobacco farming

The type of tobacco grown in the study area is flue-cured and requires use of large quantities of wood to cure tobacco resulting to forest clearance. When vegetation is cleared, soil is exposed and

therefore susceptible to both wind and water erosion. From the respondents, it is evident that tobacco cultivation had accelerated soil erosion in the study area. Almost all the respondents pointed out that soil erosion in the study area was rampant because of deforestation that was happening. This finding agrees with those of Tobin and Knausenberger (1998) who indicated that Malawi was overwhelmed by apparently obdurate environmental problems since it bore the burden of one of the world's highest rates of deforestation because of tobacco farming, the country lost almost 3 per cent of its forest cover each year, and this contributed to loss of habitat and severe soil erosion. Lecours et al (2012) concluded that in Kenya, tobacco-related environmental problems that were documented in Africa in the 1990s are still present, including widespread deforestation and the felling of indigenous trees for curing, that consequently lead to adverse soil erosion (Lecours et al, 2012). AGENDHA (2007) in their study at the North-eastern Brazil where tobacco is grown found that the area experienced forest devastation caused by tobacco farming leading to open lands with little forest cover and consequently widespread soil erosion. According to Ministry of Health & Family Welfare, Government of India (2004), another cause for soil erosion in tobacco farms is the fact that tobacco is usually planted as a single crop, tall tobacco plants do not offer much protection to top soil from eroding agents such as wind and rain, and this further exacerbate soil erosion in the farms.

5.2.2.4 Tobacco farming and deforestation

Apparently, not only is wood used for curing tobacco but also for constructing barns and preparing tobacco leaves for curing, making wood consumption high in the study area. Deforestation is a major concern in most tobacco growing zones where flue-curing is the main method of curing tobacco. Virginia type of tobacco is grown in the study area which necessitates flue curing. Study by Lecours et al (2012) shows that the production of Virginia tobacco entails flue curing, which is done in furnaces by burning wood at persistent heat temperatures for some days. In the study area, wood consumption was observed to be relatively high just like any other tobacco growing areas where flue curing method is used. At least more than 6 mature trees were used to cure tobacco. Thus, tonnes of wood were used to turn the green leaf into yellow. Therefore, tobacco farmers especially in developing countries must obtain wood from forests, their own land, or from public lands. As FCTC (2008) puts it, globally, tobacco crop takes less than 1% of the total agricultural land but its contribution to deforestation is 2-4% making a noticeable path for

climate change. FCTC (2008) further accentuate that tobacco farming may be up to 10 times more destructive than the sum of all other factors in deforestation.

The study shows that most farmers in the study area cut trees to cure tobacco. As Africa Union (2007) notes, land has been cleared in tobacco growing zones in search of wood for curing tobacco and land for tobacco production. Chacha (2001) points out that in Kuria the land had a large forest cover before the onset of tobacco farming. After the introduction of tobacco, destruction of forest cover and catchment areas became a rising concern in the area. He (Chacha, 2001) indicates that major forest areas such as Kurutiange and Maeta were cleared to pave way for tobacco farming.

Farmers in the study area had no option but to use wood to cure tobacco. This explains why logs of trees were found outside tobacco farmers' curing barns and compounds (see plate 4.2 and 4.3). Solar curing is not practiced in the study area because it is very expensive. Furthermore, it has not been introduced in the study area by tobacco companies.

It was established in this study that tobacco farmers in Kuria West (study area) bought wood from the neighbouring Maasai community in the Maasai Mara region, approximately 50 Km away, where the forests cover is still relatively high. This agrees with the report by Panos (1994) which showed that tobacco farmers in Uganda also bought wood for curing their tobacco from up to 50 kilometres away, which ate into their earnings from the crop. In the present study it was established that over time trees have been cut down in the study area for curing tobacco resulting to tree cover reduction and lack of enough wood for curing. Some of the wood was obtained from the forest illegally without permits, although Kenya Forestry Service (KFS) assured that serious action is usually taken against anybody who is found cutting down trees without a permit. In Cambodia, to overcome the problem of wood scarcities several tobacco growers bought wood from the local markets to cure tobacco because it was not easily obtainable from their environments (Bunnak and Yel, 2009). In addition, it was stated (Bunnak and Yel, 2009) that quite a number of tobacco growers also obtained fuel wood from neighbouring woodlands and backyards, including cutting down of rubber trees for tobacco curing. This coincides with the study done by Tobin and Knausenberger (1998) in Malawi explaining that scarcities of timber on habitual land led several tobacco farmers to cut trees unlawfully on public lands, as well as forest reserves and other endangered areas. Several others, although having permits, cut far in excess of

sustainable yields. Illicit and surplus cutting contributes to further erosion and siltation and impedes sustainable management of forests.

Our findings also showed that some farmers in the study area bought trees from their neighbours who had woodlots and not growing tobacco. This further put pressure on the existing tree cover in the study area. The farmers pointed out that the number of trees used depended on the acres of land under tobacco and whether the tobacco was harvested while ripe or not. From the results, 75% of the respondents consumed more than 6 mature trees per season. Since KFS did not allow a farmer to cut more than five trees according to the interview the researcher had with the Sub-county Forest Officer, most farmers ended up buying more trees from the Maasai region or cut without seeking the permit from KFS, this further deteriorated forest cover in the region and the neighbouring areas. Urambo District, a leading producer of flue-cured tobacco in Tanzania has similarly experienced a significant reduction in vegetation biomass and change in vegetation structure and consequently ecological function of the woodlands (Mangora, 2005). Mangora (2005) further states that land clearing for tobacco planting account for an annual deforestation of 3.5% while on average a farmer required 23 m³ of stacked wood only for curing per season which adds another 3% of deforestation.

5.2.2.5 Tobacco farming and biodiversity loss

Regarding forest resources, tobacco farming has been majorly responsible for the disappearance of biodiversity in the study area. Indigenous trees which used to be there no longer exist since most of them have been cut down for curing tobacco. It was established that most farmers preferred indigenous trees over exotic trees for curing tobacco because they burnt for a longer time and they gave tobacco leave a better quality. This is in agreement with the study by AGENDHA (2007), in the North-eastern tobacco growing district of Brazil where severe native biodiversity destruction from negative consequence of tobacco farming was reported. In addition, indigenous trees are known for having good quality wood for making furniture and for house construction and this explain more why the indigenous trees have been disappearing over time in the study area. However, tobacco farming remains the main reason why indigenous species were disappearing in the study area. This affirm a study done by Kibwage et al. (2014) who noted that over 50 indigenous tree species have become extinct in the region (Kuria West).

As at present, tobacco farmers continue to cut down endangered indigenous tree species without the consent of the Kenya Forest Service. The situation is anticipated to get worse and the few remaining indigenous trees (see example in plate 4.4) are likely to become extinct. The statistics shown in table 4.10 clearly point out that over time, the few remaining indigenous trees are likely to be extinct as tobacco farming continues to intensify in various places within the study area as many of the tobacco farmers (86%) did absolutely nothing to preserve the indigenous trees that were still in existence. Few farmers sought permit from the KFS offices because KFS did not consent to cutting down of indigenous trees, therefore a good number of the tobacco farmers cut down the indigenous species with no permit and this will continue to frustrate any efforts to preserve the few remaining indigenous species.

The indigenous trees in the study area had traditional uses, sentimental values and environmental benefits to the local community. Some trees were of medicinal importance; some were used for making furniture and others were fruit trees such as emepera (*Psidium guajava*). In addition, other indigenous trees that had disappeared over time in the study area were used for fencing, fodder, timber for construction, firewood and charcoal production. With the disappearance of these indigenous trees, the local community had resorted to exotic species and source for these goods and services outside the Sub-county. These findings concur with the study by Chacha (2001) who points out that many indigenous trees had been wiped out to give way for tobacco companies in Kuria West Sub-County.

In order to expand their production, tobacco farmers in Miombo Woodland put pressure on the natural resources, therefore, a cumulative volume of forest land was cleared by the growers resulting in a loss of biodiversity (Sauer and Abdallah, 2007). Moreover, Geist (1999) indicates that ungraceful sectoral guidelines, exaggerated cost of input and unsuccessful market reorganizations led to loss of biodiversity by encouraging the production of resource intensive crops. This is a clear picture of what is taking place at the study area and other tobacco growing zones, tobacco farming has consistently destroyed indigenous trees and both tobacco companies and the farmers should equally share the blame for the extensive disappearance of these trees.

5.2.3 Environmental management practices by tobacco farmers

5.2.3.1 Environmental management practices by farmers to control soil degradation

5.2.3.1.1 Crop rotation

Our results showed that majority of the respondents experienced low crop production, which was attributed to loss of soil fertility. Soil degradation is a serious form of land dilapidation and is usually characterized by soil erosion, soil compaction, low organic matter content, loss of soil structure, poor internal drainage, salinization and soil acidity problems and all these forms of soil degradation usually speed up soil erosion (Ontario Ministry of Agriculture, 2009). Soil degradation in tobacco growing zones is mainly accelerated by deforestation which causes soil erosion, excessive use of fertilizers and pesticides which leads to soil pollution and continuous cultivation of tobacco (a monocrop) that exhausts soil nutrients. Loss of soil fertility is the main impact of soil degradation in tobacco growing areas which consequently leads to low crop production. Therefore, the rationale behind crop rotation is to plant a crop that returns the nutrient to the soil that the previous plant has drawn. Growing the same crop on the same piece of land season after season results to low yields but cultivating a sequence of crops over several seasons improves soil fertility and hence increase in crop production. Bauder (1999) emphatically states that crop rotation helps to improve or retain soil fertility, reduce erosion, reduce the upsurge of pests, spread the workload, reduce risk of weather damage, reduce dependence on agricultural chemicals, and increase net profit. As OISAT (2011) notes, some insects, pests and disease-causing organisms are hosts specific and if you do not rotate a crop with other crops belonging to a different family, the problem continues as food is always available to the pest. Johnson (2014) recorded that crop rotation prevents pests and diseases such as black shank, Granville wilt, most nematodes, and tobacco mosaic as well as offers numerous agronomic benefits. He further indicates that that the longer the rotation, the better and the crop to be alternated with should be considered.

The reason why most farmers preferred rotating maize with tobacco in the study area was because maize is the staple food in the region. Since most farmers gave up their lands for tobacco production for six months, they hardly have enough food for their household. That is why the farmers grew maize immediately to ensure that they had enough food to sustain them for the next season when they grew tobacco. However, as Tobin and Knausenberger (1998) points out, rotating

tobacco with maize is not sustainable because maize has high nutrient needs but significantly less compared to tobacco. Beans were also grown by farmers. Being a legume, beans fix nitrogen to the soil that had been drawn by tobacco plant restoring partially soil fertility. Notably, rotation with crops like cassava was not favourable because cassava takes long to mature(10-18 months) depending on the variety. Rotating tobacco with tomatoes and sweet potatoes was also less favourable because the crops were easily attacked by insects and pests that linger in the soil after tobacco harvesting.

However, it was apparent from the study that quite a good number of tobacco farmers did not practice fallowing, they cultivated and planted crops year in and year out without giving the land time to respite. Fallowing is where by land is ploughed and tilled but left unplanted during a growing season to conserve moisture, control weed and favour accumulation of nitrates (UNESCO, 2009). Continuous cultivation exhausts the soil nutrients and moisture rendering the land infertile especially if the rotated crop is nutrient demanding.

Other initiative put by farmers to control soil erosion was to cultivate their land on a gentle sloping area and in flat/plain lands as shown in the figure 4.17. Most farmers preferred cultivating on flat ground because they believed they are fertile and cultivation is easy and harvesting is also easy and the land is generally less susceptible to erosion. Those who cultivated on gentle or steep slopes grew tobacco across the slope to slow down water run-off and to allow more time for the water to settle down.

However, as discussed earlier in this chapter tobacco farming requires intensive cultivation and this makes the soil prone to erosion. This is accelerated especially if the crop is grown on a steep area. A study by FAO (2011) indicates that the collapse of Guatemala around 900 AD of the 1700 year-old Mayan civilization was a result of clearing forest on the mountainsides to expand areas for farming. This accelerated soil erosion because farming was done on steep slope and this rendered the soil infertile to a point where the population could not survive.

5.2.3.1.2 Reforestation

During the survey, tobacco farmers acknowledged the importance of reforestation in the study area and they indicated that they were putting some measures in place to ensure the natural and

man-made vegetation are not being depleted. Some of these efforts include reforestation initiative. They admitted that tobacco farming involves cutting down of massive numbers of trees per season and the only way to ensure the forest resources are not depleted is by restocking the existing forests. The farmers confirmed that they were being encouraged to plant eucalyptus by tobacco companies because they matured fast compared to other species. On the other hand, farmers in the study area did not prefer planting indigenous species because they took relatively long time to mature and even after maturing, KFS could not give them permit to cut down any indigenous species because it is against the Forest Act. These among other reasons made most tobacco farmers to opt for exotic species.

Reforestation programs are very significant if at all Kenya wants to attain the 10% forest cover as required by the constitution. According to KFS (2014) Kenya has hit the 7% forest cover; this means that the country is more likely to reach the 10% forest cover. This will only be made possible if deforestation is restrained in various parts of this country. Deforestation is a nuisance in tobacco growing zones and this is mainly because the type of tobacco grown in these zones is flue-cured which entails heavy use of wood. The only way of combating deforestation in these zones is through reforestation i.e. restocking of the existing forests that have been depleted. Forests play a vital role to the environment, besides being a natural habitat of wide variety of animals and plants, trees also take the carbon dioxide that we exhale and give us the oxygen we need for respiration and as well in controlling soil erosion.

There are efforts being put in place by KFS to promote reforestation programs in the study area. For instance, KFS only allows tobacco farmers to cut down trees after they have planted others in the previous seasons and these trees should not exceed five. KFS has also ensured that farmers plant more trees than what they cut as part of the reforestation initiatives to ensure the natural ecology is not adversely affected by deforestation.

Our results show that farmers opt to plant exotic trees compared to indigenous trees despite the tremendous disappearances of the indigenous tree species. In essence, this is not a good practice as the indigenous tree species with sentimental, religious and medicinal values, food, and fodder et cetera vanish and they are replaced with foreign species. The reforestation practice in the study area is likely to encourage tobacco farmers to cut down indigenous tree knowing they will be replaced with exotic ones not bearing in mind the value they add to the livelihood of the

community. It is not surprising that during the study, it was noted that most tobacco farmers had woodlots of eucalyptus species.

With reforestation, the choice of species is equally vital. It is important to consider the climatic condition of a given place before deciding on the species to use for reforestation. It is no wonder most farmers preferred *Eucalyptus spp* to other species because of its high adaptability to any condition of soil and rain-fall and low maintenance, (FAO,2009). As much as most farmers preferred planting eucalyptus, there is lack of awareness amongst them on the negative impacts of eucalyptus species on the hydrological patterns especially if planted near water sources. *Eucalyptus spp* have been known to be drying up water sources for rivers and springs on the landscape (Forsyth et al, 2004). KFS recommends that the best areas to plant *Eucalyptus spp* include; marginal lands degraded through soil erosion and loss of soil fertility, planting as shelter belts and wind breaks on large scale farms, on areas with saline soils, water logged areas for purposes of draining the area for agricultural production and on farm lands as plantations or woodlots and the species should not be grown in wetlands and marshy areas, riparian areas, around lakes, ponds, swamps, estuary, sea shores and any other body of standing water, irrigated farm lands and areas with less than 400mm of rainfall.

Based on the interview with the farmers, it was quick to gather that other challenges facing reforestation initiatives apart from wrong choice of tree species is lack of technical advice on how to source for propagules, nursery management, silvicultural practices, and incidences of pests and diseases. According to FAO (2009), the object of the certification of tree seed and plants is to maintain and make available sources of seeds, plants and other propagating materials of superior provenances and cultivars so grown and distributed as to ensure the genetic identity and high quality of the seed and plants. Seeds that are not certified are likely to be attacked by pests and diseases and hence not do well. That is why it is important to use seedlings that are certified by KEFRI or any recognized certifying body in the country. KFS confirmed that although the tobacco farmers may not be aware of seedlings certification, all the seedlings given out by tobacco companies are obtained from KEFRI and they are certified.

5.2.3.2 Alternative sources of energy for curing tobacco

Curing tobacco leaf in the study area involved the burning up of huge quantities of wood fuel. While some tobacco requires air curing or sun curing especially in the developed countries, in the

study area, tobacco leaves are flue-cured where heat is introduced into a curing barn through pipes from an exterior furnace. And of course, the most readily available fuel for farmers to burn in these furnaces is often wood. Curing is an inevitable process for tobacco farmers since it improves the flavour of tobacco and reduces the moisture level of the leaf hence can be stored for a comparatively long time without perishing.

There are other sources of energy for curing tobacco that can be used and are environmentally friendly but are yet to be introduced in the study area. Some are also expensive for instance solar curing which involves installation of powerful solar panels that a poor farmer in the study area cannot afford. In addition, Siddiqui (2001) wrote that replacement of fuel wood for curing tobacco need to be seriously considered, describing solar energy as a feasible substitute to fuelwood. Nevertheless, Siddiqui (2001) points out that it has been assessed that solar curing can contribute about 12% of the entire heat essential for tobacco curing, however more research need to be done on this. Although solar energy appears to be a significant, nevertheless add-on source of energy, its use for tobacco curing should be well thought-out to save the environment (siddiqui, 2001).

Apparently, tobacco farmers could be willing to switch to other alternative energy for curing tobacco, but the cost associated with them is unbearable to the poor farmers for instance the cost to install solar panels. In Zimbabwe for instance, Siddiqui (2001) wrote that coal was the main source of energy for tobacco curing, however the farmers were gradually substituting it with wood, because of the doubled costs of coal, and the farmers found domestic eucalyptus to be cheaper. In the light of Zimbabwe's experience, and the fact that coal is pricier than wood in most countries, it seems to have diminutive prospect as a substitute fuel for tobacco curing (Siddiqui, 2001). However, on the contrary, in Tanzania, plans were underway to make coal found in the South-West of Tanzania an alternative to fuelwood to cure tobacco. But owing to an absence of suitable and dependable transportation infrastructure as well as lack of a pricing policy for coal, the suggestion has not so far been actualized (Sheya and Mushi, 2000).

Air curing could be a better solution for the farmer but the kind of tobacco grown in the study area cannot be air-cured. Air curing is specifically for burley and oriental tobacco that are not grown in the study area; the kind of tobacco grown in the study area is the Virginia type that requires flue-curing (BAT, 2010).

Consequently, if the tobacco companies, the government and other stakeholders will not come on board and provide an alternative for the tobacco farmers, wood will remain the only source of energy and massive destruction of forest resources will continue to be witnessed in the area. Since use of fuelwood as the only source of tobacco curing has led to massive forest destruction, Siddiqui and Rajabu (1996) recommends that alternatives to the use of wood must also be researched. For example, thought may well be given to the use of bio-waste material and solar energy to supplement the use of fuelwood. However, according to ITGA (2015), the selection of the source of energy for curing tobacco depends on factors such as availability, delivery cost, general convenience, labour requirements and efficiency. Therefore, farmers in the developing countries time and again prefer to use wood rather than alternative fuels, as it is cheap and readily available. Wood continues to be for them a fuel of necessity rather than of choice (ITGA 2015). A study by Nayak (2013) also identified reasons why farmers opted for fuelwood and not substitute fuels. Some of the explanations, for not choosing alternate fuels were: the need for an improved barn for the use of substitute fuels; impairment of curing tubes if alternative fuels are used; Unavailability of alternate fuels in needed amount. The other reason was that it was easier to obtain storage facilities for fuelwood than alternative fuels. If this study is anything to go by, then the chances of totally replacing wood with an alternate fuel will remain a mirage.

5.2.3.3 Type of barn used for curing tobacco

The study established that majority of the respondents preferred to use traditional barns to cure tobacco over improved barns. From the farmers' perspective, curing in a traditional barn takes relatively a shorter period of time as compared to the improved barns. In addition, the materials required to make an improved barn are comparatively expensive and that is why most farmers opt for a traditional barn.

According to Tippayawong et al (2004), there are no extra insulators installed on the roofs or the walls of the traditional barn, therefore a lot of heat is lost to the surrounding, the modern improved barns have better insulation fitting and a modified furnace that prevents heat loss through the walls and the roofs. This minimizes the amount of wood that is required to cure tobacco.

This study has shown that destruction of the forest resources is compounded by using traditional barns that are preferred by majority of the tobacco farmers. The traditional barns have low

thermal efficiency hence consume larger quantities of firewood thus contributing to accelerated deforestation, with serious ecological implications. In Miombo woodland where deforestation is a main concern majorly contributed by tobacco farming, 60% of farmers used traditional barns whose energy efficiency is low (Sauer and Abdallah, 2007). Their (Sauer and Abdallah, 2005) experimental results strongly propose that agricultural policy actions ought to emphasize on promotion of improved barns in Miombo woodland to reduce deforestation in the region. In Malawi, 55,000 hectares of land is cleared annually to cure tobacco accounting for 12% deforestation in the region. Consequently, Limbe Leaf and German Technical Cooperation teamed up to promote rocket barns that reduce wood use by 50% for curing (Scott, 2009). An experimental study by Siddiqui (2001) on the performance and efficiency of Malakisi barn (a traditional barn common in East and Southern Africa and is normally used by tobacco farmers to cure tobacco) concluded that 97% of heat is lost in a traditional barn, therefore rendering it inefficient. In view of the adverse environmental effects of existing tobacco curing practice, Siddiqui (2001) recommends an urgent necessity to increase the efficiency of the procedure by enhancements in the furnace and flue pipe system design and to seek alternative sources of energy. In addition, sufficient emphasis has not been given by tobacco companies and relevant government sectors on energy conservation and ecological consideration in tobacco curing practice. Considering the above, there is an urgent necessity for the farmers in the study area to be encouraged to use barns with improved structure to minimize excessive use of wood to cure tobacco.

5.2.3.4 Initiatives by farmers to minimize excessive use of wood

The researcher explored the various initiatives being practiced by farmers to minimize excessive use of wood. The findings showed that the few measures farmers were putting in place to reduce excessive use of wood are inconsequential. A few farmers used improved barns with well insulated walls minimizes heat loss through roofs and walls hence less wood consumption. Some re-used wood in the construction of barns from demolished structures reducing cost of construction and preserves trees. Re-using wood for construction of barns ensured that farmers do not throw away perfectly good pieces of wood when demolishing an old house and in doing so they minimized cutting down of more trees for construction. Farmers also re-used old wood from an old barn to modify the same barn thus reducing the necessity of cutting down trees for construction of a new barn. However, since curing of tobacco is the main cause of deforestation in tobacco growing zones and only 10% of farmers used improved barns, then the rest of their efforts are insignificant. Mangora (2005) in his study recommended that improved barns that

capitalized on the heat they produced and alternative sources of fuel like coal should be explored to reduce wood consumption.

Some of the tobacco farmers in the study area harvested only ripe tobacco leaves as an initiative to reduce the amount of wood required to cure tobacco. Ripe tobacco leaves require less time to cure as compared to unripe and immature leaves consequently minimizing wood consumption. Reed (2009) affirms by stating that harvesting only ripe tobacco ensured shorter curing time and lesser heat loss and more efficient curing. According to the University of Georgia College (2010), tobacco leaves reach full maturity a few days before ripening and mature leaves exhibit a slight yellowing and wrinkling between veins and break off the stalk easier than immature leaves.

5.2.3.5 Initiatives by tobacco farmers to prevent cutting down of indigenous trees species

Eucalyptus treespecies were preferred since tobacco companies advised farmers to plant them owing to their fast growth and their ability to grow in many agro-ecological environments. The study revealed that 19% of respondents supported cutting down of indigenous trees because of their ability to burn for a long time in the tobacco furnace producing good quality tobacco leaves. Similar results have been recorded in Tanzania where 40 million kg of tobacco is produced by 200,000 smallholder farmers, using an even less efficient curing system using only indigenous forests (Scott, 2009). Only 4% used other alternatives for curing tobacco other than wood from indigenous tree and this include use of leaves and twigs cut from exotic trees.

Farmers continue to depend on indigenous trees as an energy source, Malawi for instance, indigenous forests provide as much as 90 per cent of the annual demand for energy(Tobin and Knausenberger, 1998). A study by Geist et al (2009) on Miombo woodland confirms that In Tanzania, indigenous tree species of the miombo woodlands (e.g., *Brachystegia speciformis*) were mainly preferred by tobacco growers. As reported by Lecours et al (2012), widespread deforestation and the felling of indigenous trees for curing tobacco is still rampant in tobacco growing areas and they are cut down without being replaced.

More initiatives need to be put in place to conserve indigenous trees in the study area to prevent further reduction of the indigenous tree cover because of their importance to the local people.

5.2.4 Environmental management practices by tobacco companies

5.2.4.1 Sensitization on environmental management practices by tobacco companies

The study established that tree planting was the highest environmental management activity practiced by farmers who needed enough wood to cure tobacco. This was enforced by KFS who encourage tree planting by use of the motto: for every one tree you cut, you must plant at least five. Furthermore, tobacco companies encourage farmers to plant trees to ensure they have enough stock in future for curing tobacco. Weak (28%) sensitization measures of tobacco farmers on environmental conservation could majorly explains why forest and soil resources conservation is overlooked in the study area.

Our results (table 4.16) evidently show that tobacco companies are not doing enough to promote sustainable agriculture, in that, besides getting good harvest, they should be mindful of the environment and they should restrain from practices that degrade the soil and forest resources. Sustainable agriculture aimed at crop production in a way that does not degrade the environment and contributes to the livelihood of communities is a sure way of balancing production, environmental, and community development goals (University of Kentucky, 2009). Sustainable agriculture such as rotations, intercropping, and companion planting; protecting water quality; composting; year-round soil cover; integrating crop and animal production; riverine protection, soil conservation practices are all good in protecting the soil and forest resources (University of Kentucky, 2009). According to Horrigan et al (2002) sustainable agriculture gives due consideration to long-term interests (e.g., preserving topsoil, biodiversity, and rural communities) rather than only short-term interests such as profit. Sustainable agriculture is also place specific. Sustainable agriculture does not refer to a prescribed set of practices. Instead, it challenges producers to think about the long-term implications of practices and the broad interactions and dynamics of agricultural systems.

Based on the study, using improved barn is the least sensitized method for conserving soil and forest resources by tobacco companies. Considering curing is the main cause of deforestation in the region, this illustrate lack of initiative by tobacco companies to encourage tobacco farmers to use energy conserving methods such as improved barns and introduce other methods of curing besides flue curing to spare the forest and soil resources from destruction. A research by Matibe

(2011) states that with efficient curing management and improved barn structures by tobacco small scale growers, wood/energy consumption will be reduced to almost half.

5.2.4.2 Trees Species planted by farmers as an initiative by tobacco companies to promote afforestation/reforestation

The research findings show that Eucalyptus was the most preferred species for reforestation promoted by tobacco companies. According to Panos (1994), *Eucalyptus spp* is known to be BAT's favourite species. Eucalyptus seedlings are easily available and they grow fast under adverse condition. Because of their fast growth, eucalyptus trees absorb lot of nutrients and water accelerating soil fertility declination and land degradation in general. From this study, it is evident that tobacco industry reforestation schemes have little or no positive impact because the trees planted are non-native and used for tobacco production. Planting eucalyptus, cypresses and other non-native plants is problematic because the trees absorb excessive amounts of water that harm food crops and lowering water tables. Panos (1994) emphasizes this by stating that eucalyptus grows fast, even in harsh conditions by up taking underground water, consequently lowering the water table. Kweyuh (1994) affirms that the key setback in the reforestation programme was that it involved only fast-growing exotic trees such as cypress and eucalyptus. This shows that the environmentally appropriate indigenous trees of the region were not substituted. The species used for reforestation were unsuitable because of the additional attention and large amounts of ground water required, leading to further hostile environmental consequences.

According to this study tobacco companies are on the forefront promoting reforestation using exotic species (table 4.17). Panos (1994) shows that in Kenya, for instance, BAT allows you to become a tobacco farmer only after you have planted 1000 Eucalyptus trees. This is ecologically intolerable bearing in mind the undesirable impacts eucalyptus is likely to have to the environment. Although BAT encouraged farmers to grow eucalyptus, another study by Chacha (2001) indicates that since the aroma of the final cured tobacco especially of the flue-cured tobacco depended on the nature of tree used in curing, for this reason, the BAT staff continued to encourage farmers to use other sources than eucalyptus so that what was happening in the district (Kuria) was a transformation from indigenous vegetation into an exotic eucalyptus one. Reforestation activities in tobacco growing zones are uncontrolled that is why indigenous species continue to be replaced by exotic ones. Another major setback is that government officials in least developed nations not having funds to run their own reforestation programmes are hesitant to

criticize tobacco industries to continue receiving money to support their reforestation activities (Patel et al, 2007). Therefore, it is presumable that since there are no strong policies to guide reforestation programmes or because tobacco companies jeopardize the implementation of the existing policies, reforestation initiatives will remain unsuccessful.

Otanez et al (2011) further indicates that tobacco companies' reforestation systems have little or no progressive impact since the trees planted are not indigenous and used for tobacco production. They (Otanez et al, 2011)note that growing eucalyptus, cypresses and other non-indigenous trees is challenging because the plants absorb too much water that damage food crops and reduce drinking water tables. The insatiable demand for firewood also make reforestation programs to have little impact because forests are cut down before they regenerate to meet the high demand for wood to cure tobacco (Loker, 2005). This is because reforestation has been specifically introduced to provide wood for the building of drying and grading barns and fuel for curing barns (B,S,S Economic Consultants 2010). Basically, tobacco companies support reforestation programmes with the intention of wanting to appear endorsing environmentally sustainable initiatives in tobacco growing communities to improve their companies' images without essentially altering their fundamental business practices (Haskall, 2008).

5.2.4.3 Technical and education training by tobacco companies

The technical and education training is supposed to be carried out by leaf technician/field officers right from when the tobacco is in nursery to when it is being sorted and graded. It is the responsibility of the field officers from tobacco companies to sensitize their farmers on effective and environmentally sensitive approach to tobacco farming. Tobacco farmer training on appropriate forest and soil resources utilization should be one of the most important strategy of ensuring the environment is protected from destruction. The technical and education training varies from proper fertilizer and pesticide use, adoption of integrated pesticide management, appropriate choice of tree species for reforestation to sustainable soil management practices et cetera. Tobacco companies claim to be offering training both to extension workers and tobacco farmers. Only when extension workers have gained comprehensive knowledge are they able to transfer technology through routine farm inspection and regular meeting with farmer groups, the training majorly evolve around fertilizing, pest and disease control (Eaton and Shepherd, 2001). Tobacco companies need to ensure these training are also focused towards ensuring a sound

environmental conservation and not only in the direction of ensuring maximum harvest and quality of leaves is obtained from the tobacco farms.

Appropriate use of fertilizers and pesticides provides high yields without undermining the natural systems and resources that productivity depends on. Fertilizers are used to increase crop yields and to replace soil nutrients removed with harvested crops to reverse the trend of declining soil nutrients that lead to low crop productivity. But when applied in excess, the plants can easily exhibit symptoms of oversupply that may lead to poor growth, productivity and eventually death. Excess fertilizer causes soil toxicity and pollution which eventually lead to soil degradation (Gruhn et al, 2000). Excessive application of pesticides causes soil contamination that can be persistent for a long time and can kill soil microorganisms and decrease soil organic matter and this can make the soil unproductive. Since tobacco companies are aiming at maximizing tobacco production, they are compelled to offer technical advice to tobacco farmers on appropriate fertilizer and pesticide use in order to optimize yields and produce quality tobacco leaf. Apparently, the technical advice offered to farmers is not necessarily meant to ensure the environmental quality is not compromised but to guarantee the tobacco companies of good and quality yields. In India, there has been a push by NGOs to compel tobacco companies to offer technical advice on integrated pest management; however, tobacco industries consistently promote the use of more agrochemicals. Biological pesticides which are equally toxic to insect pests, such as *Bacillus thuringiensis* are rarely used (Ministry of Health & Family Welfare, Government of India, 2004).

The survey showed that almost a quarter of the respondents had not received any training or education from any tobacco company on environmentally acceptable way of farming tobacco. Most of the farmers consequently utilized the forest and soil resources without putting in any environmental concerns and this will eventually destroy the environment.

Soil management practices such as crop rotation, strip cropping, mulching, cover cropping, zero tillage and contour farming are not being emphasized by tobacco companies, where a negligible 4% respondents admitted to practicing. This should not be the case because if the soils are degraded, it means there will be low or no yields from the farm and the farmers will be economically devastated, including facing food insecurity. On the contrary, in places like India, tobacco Board and local extension workers offer technical advice against two successive seasons of planting tobacco because of their detrimental effects on soil fertility, (Ministry of Health &

Family Welfare, Government of India, 2004). However, there is a concern that tobacco companies do not follow up to ensure this is implemented.

5.2.4.4 Alternative Methods of pest control tobacco farmers have been advised to use by tobacco companies over Chemical Pesticides

Most farmers believed that biological control did not totally eliminate pests from tobacco crop and besides it was not a common practice in the study area and most farmers did not know how it actually works. The use of chemical pesticides to control pest problems is effective but is detrimental to the environment. Massive chemical pesticide application causes reduction of important microorganisms and insects in the soil.

Lecours et. (2012) in their study concluded that excessive use of harmful agrochemicals and the shifting of tobacco growing into more fertile lands encouraged by tobacco industry contributes to the environmental health impact of tobacco cultivation in Low and medium income countries (LMICs).

From the study, it is obvious Tobacco companies are on the forefront encouraging the use of chemical pesticides which are injurious to the environment instead of finding alternatives that are environmentally friendly. A study by Torres (2000) shows that up to 16 applications of pesticides are required by BAT of its contract farmers. Therefore, a new way of controlling pests that is effective and does not harm the environment must be adopted. Such methods include biological control that uses a parasite or a predator that causes harm only to the targeted pests (FAO, 2012).

The data collected indicated that 100% of the respondents had not been encouraged to use any alternative fertilizer apart from inorganic based fertilizer for their tobacco crop. Farmers were discouraged by tobacco companies from using organic fertilizer, which they were told can easily burn the tobacco leaves thereby reducing its quality. For that reason, farmers are left with no option but to continue inorganic fertilizer application provided by tobacco companies on loan regardless of their effects to the environment. There are several methods that can restore back soil fertility without necessarily heavy application of inorganic based fertilizers and this include crop rotation and extending fallow periods which should be encouraged amongst tobacco farmers. However, tobacco companies are reluctant to advise the farmers to use alternatives to chemical pesticides and fertilizers because of the economic benefits they derive from such an arrangement. Tobacco Free Kids (2001) notes that in 1998, tobacco industries in the Rio Azul province of

Paraná state in Brazil anticipated to make huge profit of two million US Dollar by selling chemicals to the tobacco growers. Lecours et al (2012) indicate that tobacco industries by enthusiastically regulating the sale of chemical pesticides and fertilizers in the world, they inspire the usage of goods which have demonstrated to be very detrimental to the environmental and have basically bound tobacco farmers through contract in the production arrangement.

5.2.4.5 Soil management practices promoted by tobacco companies

Some of the soil management practices include crop rotation, use of cover crops, strip cropping, multiple cropping, zero tillage and re-vegetation. However, from the study, these practices are hardly promoted by tobacco companies. This undoubtedly confirms that not much has been done by tobacco companies to manage and protect soil resources from degradation by promoting sound management practices. Tobacco industries by not encouraging soil management practices has led for instance reduced pH of soil and elevated contents of effective N,P and K significantly under the standard application condition and release of poisonous substances into soil (Changhua1 et al, 2007).

Sound soil management maintains good soil fertility, texture and structure of the soil and increases microbial activities. A properly managed soil result to high crop yields because it's fertile and a poorly managed soil result to low crop yield because of loss of fertility and it is susceptible to erosion. Since the introduction of tobacco, soil resources have continued to deteriorate thanks to the expansive activities of tobacco companies. Kutub and Falgunee (2015) research findings indicate that tobacco farming being promoted by British American Tobacco in Bangladesh had led to severe soil pollution, low soil fertility and has affected soil quality.

5.2.4.6 Alternative sources of energy promoted by tobacco companies other than wood

Almost all the tobacco farmers believed tobacco companies did not promote alternatives sources of energy other than wood. Other sources of energy such as solar are non-existing. There are very few evidences in the developing countries where tobacco farmers use alternative sources of energy where flue cured tobacco is grown. Nevertheless, according to CTA (2003), in Malawi, a project working with tobacco farmers is proving that solar-generated electricity can play a useful part in agricultural production as well as environmental conservation, but this study does not show whether the farmers have adopted this technology and if the said technology is sustainable. BAT (2016) alleges to be encouraging some of their farmers on contract to cure their tobacco with

appropriate, locally available alternative fuels. These include gas, sawdust, coal, candlenut shells or liquid petroleum gas, as well as coffee or rice paddy husks. However most of these alternatives are expensive and some unavailable in several tobacco growing zones. In most countries, there is no alternative fuel other than wood as seen in Tanzania and Malawi (Torres, 2000). This is further pointed out in Nayak (2013) study whose findings show that there were few alternatives to the dominant use of fuelwood in tobacco curing in Karnataka, India.

From the findings of this study, practically nothing is being done by tobacco companies to provide other alternatives to curing tobacco other than wood. This is likely to compromise further the tree cover in the study area.

5.3 Conclusions

5.3.1 Impacts of tobacco farming on soil and forest resources

The first objective of this study was to explore the impacts of tobacco farming on soil and forest resources in Kuria West Sub-county. From the study, it is apparent that tobacco farming has adverse effects to the environment if environmental concerns are not integrated in the farming activities. Some of these impacts include deforestation, soil erosion, soil pollution and soil infertility. Tobacco farming has been seen to cause soil pollution through unregulated fertilizer and pesticide application in the study area. This is evident as most farmers confirmed that they did not seek for technical advice before applying fertilizers and pesticides. Excessive application of these chemicals could cause soil toxicity and consequently kill soil microorganism leading to low soil fertility. Tobacco being a nutrient demanding crop extracts much of the nutrients from the soil causing low soil fertility, especially if the soil is not replenished through soil management practices such as crop rotation, cover cropping, mulching strip cropping among others, which were not popular practices in the study area as seen in this study. The existence of soil erosion in the study area is attributed to uncontrolled deforestation and as a result this has led to low soil fertility and low crop production.

Another detrimental impact of tobacco farming is deforestation. A substantial number of trees were cut down every year by tobacco farmers in the study area for curing tobacco, building curing barns and for preparing tobacco leaves for curing. The study established that flue curing method was the only one applied. The other better energy saving methods such as solar curing are yet to be introduced and are also expensive and unaffordable. Therefore, farmers cut down several

mature trees per season for curing tobacco, constructing curing barns and for preparing tobacco leaves for curing and this had greatly reduced forest and tree cover in the study area. Tobacco farming is majorly responsible for the disappearance of indigenous tree species in the study area. There is a noted preference by tobacco farmers in using indigenous trees for curing since they burn for a long time and they are believed to produce good quality leaves with a pleasant aroma. Therefore, the preferred indigenous tree species have been depleted from the study area and only memories remain among the farmers.

Consequently, indigenous fuelwood trees are now being sourced from the neighbouring Maasai regions, about 50 km from the study area. The situation is likely to get worse in the near future.

5.3.2 Environmental management practices being carried out by tobacco farmers

The second objective of this study was to examine the environmental management practices being practiced by tobacco farmers. It was evident from the study that the only major environmental management practices being carried out by tobacco farmers were reforestation/afforestation and crop rotation. Nevertheless, the two environmental management practices were implemented using less desirable species i.e *Eucalyptus spp* for reforestation and maize for crop rotation. It was noticeable that the only soil management practices taking place in the study area was crop rotation. However, it was not clear whether the respondents practiced crop rotation as a soil management practice or out of the need to have food to feed the family hence they had to plant food crops as soon as tobacco was harvested until the next tobacco season. Rotating tobacco with maize is the most popular practice. However, maize has high nutrient demands but significantly less compared to tobacco, therefore rotating maize with tobacco further exhausts the remaining nutrients in the soil. Other soil management practices such as strip cropping, mulching, zero tillage and cover crops are yet to be introduced. It emerged from the study that regardless of the negative impacts tobacco has on the soil resources, not much is being done to mitigate these impacts and as a result soil degradation continues to be rampant in the study area.

Reforestation has been used as a management practice to ensure forest and soil resources are not destroyed. Most respondents in the study area preferred using eucalyptus species for reforestation because of their ability to mature fast and grow under diverse conditions. Other tree species used for reforestation included *Grevillea robusta*, *Cupressus spp*, *Jacaranda spp* and *Olea africana*. It

was obvious that most of the respondents did not consider the negative environmental impacts of exotic species particularly eucalyptus on hydrological patterns especially if planted near water sources. The study established that most of the tree seedlings were sourced locally and had not been certified by a recognized certifying body in the country. Uncertified seedlings have been linked to outbreak of pests and diseases and the trees from these seedlings are usually of stunted growth. It is worthwhile noting that all respondents did not consider using indigenous species for reforestation. This explains why the forest cover for indigenous species has been replaced by exotic species in the study area.

The study revealed that most of the respondents used wood to cure tobacco while very few used twigs and leaves from trees. Other curing method such as solar and air curing were virtually absent in the study area partly because they are expensive and have not been popularized and because the type of tobacco grown in the study requires flue curing only. This has contributed to the high rate of deforestation in the study area. Furthermore, majority of the respondents prefer to use the traditional barn over the improved barn. A traditional barn consumes more wood as compared to an improved barn with well insulated wall to minimize heat loss.

Other initiatives being put in place to curtail deforestation include harvesting only ripe tobacco which require less curing and re-using wood in the construction of barns.

The farmers were slightly putting in efforts to prevent cutting down of indigenous trees which were becoming extinct in the study area. The major strategy employed by tobacco farmers included planting of exotic trees for curing tobacco. But despite their efforts to conserve the indigenous species, it was confirmed that most of these species are now extinct. This is partly because the farmers have been convinced that the indigenous species produce good quality tobacco leaves with a pleasant aroma.

Therefore, this study concludes that the efforts by tobacco farmers to conserve forest and soil resources are still negligible; still much has to be done and improved.

5.3.3 Environmental management practices by tobacco companies

The Third objective of this study was to evaluate the environmental management practices by tobacco companies to control soil and forest resources degradation. It is ostensible that there are very few environmental management practices promoted by tobacco companies to combat deforestation, tree planting being the common practice in the area. However other practices that can control forest resources degradation such as sustainable agriculture and use of improved barns though in existence are not common amongst farmers. Tobacco companies encourage their farmers to grow eucalyptus species because of their ability to grow faster and they can thrive in harsh conditions.

It was also perceptible that many farmers had not been sensitized on any environmental management practice by any tobacco company. This vividly shows that environmental awareness by tobacco companies is still poor. On the other hand, tree planting practice alone cannot eradicate forest and soil resources degradation without incorporating other practices such as use of improved barns and use of alternative sources of energy which are not common in the study area.

Other initiatives by tobacco companies included offering technical education and training to farmers which is carried out by leaf technician/field officers right from when the tobacco is in nursery to when it is being sorted and graded. Appropriate use of fertilizers and pesticides was the main training conducted by tobacco companies because of their adverse effects on the tobacco crop and soil. However other technical trainings are equally important but they were disregarded by the tobacco companies, creating opportunity for environmental degradation. These technical trainings include sustainable soil management, appropriate choice of tree species for reforestation and afforestation, use of improved barns and other sources of energy for curing tobacco other than wood. Despite being advised on appropriate use of fertilizers and pesticide, tobacco farmers are not recommended to use alternative pest and disease control methods that are environmentally friendly other than chemical pesticides. Chemical pesticides are known to destroy soil organism and structure as well as cause soil toxicity among others. It was also evident that tobacco farmers are only encouraged to use inorganic fertilizers which are detrimental to the environment.

The study indicates that not much is being done by tobacco companies to promote soil management practices. Nevertheless, a few farmers said tobacco companies encourage them to

rotate their crops in order to give the soil time to recover the lost nutrients. However as seen in the study, the crop (maize) mainly used for rotation is equally a nutrient demanding crop and therefore puts more pressure on the remaining soil nutrients.

It is important to note that tobacco companies have done little to promote other alternative sources of energy other than wood; they had encouraged very few farmers to minimize consumption of wood by promoting use of improved barns. Nevertheless, they encouraged reuse of wood in construction of curing barns, ensured farmers harvest only ripe tobacco leaves which requires less curing and encourage farmers to consider use of bricks in construction of barns. However, these efforts are negligible considering the fact curing is the main reason for deforestation.

From the study, it was revealed that although tobacco companies are said to be promoting a few environmental management practices to control destruction of soil and forest resources, they lack implementation strategies and they do not make follow ups to ensure the practices are being employed. This has made the tobacco companies to totally fail in their supposed efforts to conserve the environment.

From the study, one can evidently note that tobacco companies do not put much concern on what happens to the environment but rather are more interested in the final product and quality of the tobacco leaves.

5.4 Recommendations

5.4.1 Impacts of tobacco farming to the Forest and soil resources

- 1) There should be limited use of chemical pesticides as part of pest management or alternatively tobacco companies should research and introduce botanical pesticides and biological control to reduce soil pollution. Moreover, the use of organic fertilizers should be encouraged among tobacco farmers over inorganic fertilizers.
- 2) To avert biodiversity loss, strict laws should be used against any person found cutting down indigenous trees. On the same note, tobacco companies should consider promoting indigenous species for reforestation rather than exotic species.

- 3) The Government agencies should consider replacing tobacco farming with other economically viable livelihoods with little or no negative impact to the environment.
- 4) NEMA should ensure that all farms intended for tobacco farming undergo an Environmental Impact Assessment because of their significant impact to the environment and lack of sufficient mitigation measures. These farms should as well be regularly audited. According to second schedule of EMCA Cap 387, projects that involve timber harvesting, clearance of forest areas, reforestation/afforestation with alien species (e.g. exotic trees), widespread introduction of fertilizers and actions likely to affect endangered species of flora and fauna should all undergo an EIA process, activities involving tobacco farming are no exception.

5.4.2 Environmental Management Practices amongst tobacco farmers

- 1) The study indicates that crop rotation is the only soil management practice in the region. However, the crop used for rotation should be nutrient adding and not nutrient demanding crop. Farmers should incorporate other practices such as contour ploughing to control surface run off from tobacco farms and intercrop tobacco crop with high nitrogen utilizing crops such as cereals to avoid leaching of nitrates into soil leading to loss of soil nutrients.
- 2) Farmers should seek for technical advice before applying agrochemicals to the tobacco crops. This is because excessive applications of these chemicals is harmful to the soil.

5.4.3 Environmental Management Practices by tobacco companies

- 1) Tobacco companies should introduce and promote alternatives to curing tobacco other than flue curing such as solar curing that does not deplete tree and forest cover.
- 2) Tobacco companies should do research and introduce another variety of tobacco crop that does not require flue-curing such as burley tobacco which is air-cured. Since tobacco curing is the main cause of deforestation, the introduction of such species will reduce the amount of wood needed for curing tobacco crop.

- 3) Tobacco companies should be on the fore front in sensitizing farmers to carry out environmental management practices in the study area to prevent environmental degradation. These companies should start workshops to train and educate the farmers on the same on a regular basis and make frequent follow ups on the implementation of these practices.

Areas of further research

- 1) A study to determine if burley tobacco (air cured tobacco) can do well in the study area. This is because the type of tobacco grown in the study area (flue cured tobacco) is majorly responsible for the deforestation problems.
- 2) A study to determine if biological control methods are effective in eliminating pests in tobacco farms. The reason being, tobacco farmers heavily depend on chemical pesticides and fertilizers that have harmful impact to the soils in the long run.

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APPENDIX

- Sample questionnaire

1. General/Demographic Information

1.1 Respondent's Name

1.2 Name/Gender of Household's head:

Male: Female:

1.3 Age (yrs)

- Below 20
- 20-29
- 30-39
- 40-49
- 50-59
- 60-69
- 70 and above

1.4 Marital status

- Married
- Single
- Divorced
- Widowed
- Any other

1.5 Level of education

- Primary
- Secondary
- College/university
- Never gone to school

1.6 For how long have you been a tobacco farmer?

- 1-3
- 4-6
- 7-9
- 10-12
- 13-15
- More than 15 years

1.7 What is the acre of land under tobacco farming? ----- Acres

- 0-2

- 3-5
- 6-8
- 8-10
- More than 10 acres

1.8 What other crops do you plant apart from tobacco?

- Maize
- Beans
- Millet
- Sorghum
- Vegetables
- Cassava
- Sweet potatoes
- Others.....specify.....

2. Impacts of tobacco farming to Forest and Soil resources

2.1 What type of pesticides do you apply on your tobacco farm(s)?

- Confidor
- Starthene
- Copper
- Thunder
- Bulldock
- Offshoot
- Lunnate
- Orthene
- Dusbune
- Others (specify).....

ii. How many bags (5kg each) of pesticides do you apply per acre in a tobacco farm?

- 1-2
- 3-4
- 5-6
- 7-8
- Above 8
- I don't apply

2.2 What type of fertilizers do you apply on your tobacco farm(s)?

- Ammonium nitrate
- Calcium nitrate
- Potassium nitrate
- Diammonium phosphate

ii. How many times/often do you apply the fertilizers after planting tobacco?

- Once
- Twice

- Thrice
- Four times
- More than four times
- I don't apply

iii. How many bags of fertilizer do you apply per acre in a tobacco farm?

- 1-2
- 3-4
- 5-6
- 7-8
- Above 8
- I don't apply

iv. How often do you seek for technical advice before applying the fertilizers and the pesticides?

- Anytime before I apply the fertilizers and the pesticides
- Only when I get the chance to seek for advice
- I don't seek for advice
- Others(specify)

2.3 How do you ensure that the amounts of fertilizers applied are not at levels that are detrimental to plants and soil organisms?

- By applying only the recommended amount
- By seeking for technical advice from an expert
- I have never known excessive fertilizer application affects soil microorganism
- Others (specify)

2.4 What physical changes have you observed on the soils where tobacco is grown?

- Rough texture
- Very smooth texture
- Reduction in clay content
- The soils cannot hold water for a long time
- Water logging
- I have not observed any change

2.5 How has repeated tobacco cultivation affected soil fertility in your farm?

- It has led to soil erosion
- Low crop production
- Soil pollution due excessive fertilizer and pesticide use
- It has not affected soil fertility in my farm in anyway
- Others.....specify.....

2.6. What type of crops do you rotate tobacco with?

- Maize

- Beans
- Millet
- Sorghum
- Vegetables
- Cassava
- Tomatoes
- Sweet potatoes
- Others.....specify

iii. After how long do you rotate the crops with tobacco?

- 1-2 years
- 3-4 years
- 4-5 years
- Above 5 years

2.7 How do you compare other crops production on a piece of land where tobacco used/or had been grown for sometime

- Very good
- Good
- Poor
- No difference

2.8 What problems have you experienced as a result of soil erosion ever since you started tobacco farming?

- Low crop production
- Low soil fertility
- Pest infestation
- Weed infestation
- Disease infestation
- Others (specify)

2.9 Where do you grow tobacco?

- Steep slopes
- Gentle slopes
- Flat/ plain lands
- River banks
- Wetlands
- Others

2.10 What might have led to the soil erosion?

- Cutting down of trees to cure tobacco
- Cultivation of tobacco in the fragile lands e.g at the steep slope, river banks etc
- Intensive tobacco cultivation

- Others(specify)
- I don't know

2.11 How do you compare soil erosion where you have grown tobacco and where you have grown other crops?

- Severe
- Moderate
- No difference

2.12 For what purpose do you cut down trees for during tobacco seasons?

- To construct barns
- For curing tobacco
- To get poles and sticks for preparing tobacco leaves for cure
- To clear land to grow tobacco
- Others(specify).....

2.13 What type of curing do you use?

- Air curing
- Solar curing
- Flue curing
- Fire curing (uses twigs and leaves)

2.14. Where do you get wood for curing tobacco?

- From a forest
- From my woodlot
- From a neighbor
- I buy
- From tobacco companies

2.15 How many mature trees are you likely to use during curing of tobacco for one season?

- 1-5
- 6-10
- 11-15
- 16-20
- More than 20

2.16 How do you ensure that endangered or threatened species of wildlife or flora are not adversely affected by the deforestation?

- By not cutting them down
- By seeking for permit from the forestry offices before cutting them down

- I cut them down for curing tobacco because I have no otherwise
- Through afforestation/reforestation
- I do nothing

2.17 How do you compare tree cover (indigenous trees) in your sub-location 20 years ago and as at present?

- Increased
- Reduced
- No difference

2.18 For what purpose do you cut down indigenous trees for?

- Tobacco curing
- Construction
- Making furniture
- I don't cut down indigenous trees
- Others(Specify).....

2.19 If the indigenous trees that were there before you started tobacco farming are not in existence, why were they cut down?

- Tobacco curing
- Construction
- Making furniture
- They are still in existence
- Others(Specify).....

2.20 Mention all indigenous trees that have disappeared over time and their traditional uses

S/N	Local Names	English Name	Botanical Name	Traditional uses
1.				
2.				
3.				
4.				
5.				
6.				
7.				

2.21 What other subsistence use do you use wood for apart from curing tobacco?

- Firewood
- Fodder
- Timber construction
- Making furniture
- Charcoal production
- Fencing
- Others (specify)

- There are no enough trees for the above subsistence use

3.Environmental Management Practices for Soil and forest resources conservation

3.1 What Environmental management practices do you carry out in your tobacco farm to control soil erosion?

- Crop rotation
- Cover crops
- Strip cropping
- Multiple crops
- Mulching
- Zero tillage
- Contour farming
- Revegetation
- Avoiding cutting trees in fragile ecosystems e.g. river banks and water catchment areas
- None

Give descriptive details of each of the above

Crop rotation

Cover crops

Strip cropping

Multiple crops

Mulching

Zero tillage

Contour farming

Revegetation

3.2 Mention the tree species you plant after cutting down the trees for curing tobacco

3.3 Are the tree seedlings used in nurseries certified by Kenya Forestry Research Institute (KEFRI)?

- Yes
- No
- I don't know

3.4 What other type of alternative energy apart from wood do you use for curing tobacco?

- Solar energy
- Fire curing (uses twigs and leaves only)
- There is no other alternative
- Others (Specify).....

3.5 What type of barn do you use for curing tobacco?

- Improved barn/furnace
- Traditional barn (Non-energy saving)
- Others.....specify

3.6 What initiatives have you put in place to minimize excessive use of wood that leads to deforestation?

- By promoting use of improved barns
- Encourage reuse of wood in construction of curing barns
- Ensure tobacco farmers harvest only ripe tobacco which requires less curing
- consider reuse of wood in construction of curing barns
- Encourage farmers to construct curing barns with insulated walls and floors

- Encourage farmers to consider use of bricks in construction of curing barns other than tree
- None

3.7 What initiative have you put in place to prevent cutting down of endangered indigenous species

- By planting exotic trees for curing tobacco
- By obtaining permits from the relevant government authorities before cutting endangered indigenous trees
- Using other alternative for curing tobacco other than wood
- I have cut them down for curing tobacco because I don't have an option
- I have done nothing

4. Environmental management practices by tobacco companies

4.1 What environmental management practices have you been sensitized on by tobacco companies?

- Tree planting
- On sustainable agriculture
- Use of alternative source of energy
- Use of improved barns
- Others.....specify.....
- None

4.2 Name any species of trees you have planted as an initiative by tobacco companies to promote afforestation/reforestation

4.3 Name any technical education and training you have received from tobacco companies on tobacco farming Do the tobacco companies promote adoption of IPM (Integrated Pest Management) on pesticide practices through farmer education and training?

- Adoption of integrated pest management
- Appropriate use of fertilizers and pesticides
- Appropriate trees species to be used for reforestation/afforestation
- Sustainable soil management practices
- Others(specify)
- None

4.4 What kind of pesticides have you been advised to use over chemical pesticides?

- Organic matter
- Botanical pesticides
- Biological control
- We have not been advised to use other types of pesticides
- Others (Specify)

4.5 What measures have the tobacco companies taken to limit inorganic based fertilizer use?

- Encourage use of organic fertilizer

- Promote alternating crops
- Encouraged use of planting cycles
- None
- Others (specify)

4.6 What soil management practices are being promoted by tobacco companies?

- Crop rotation
- Cover crops
- Strip cropping
- Multiple crops
- Mulching
- Zero tillage
- Revegetation
- None
- Others.....specify.....

4.7. What alternative sources of energy do tobacco companies promote for curing tobacco other than wood?

- Solar energy
- Fire curing (uses twigs and leaves only)
- None
- Others (Specify).....

Give a story/ details of the above (take pictures of the same)

4.8 How do the tobacco companies ensure that use of excessive wood fuel is minimized?

- By promoting use of improved barns
- Encourage reuse of wood in construction of curing barns
- Ensure tobacco farmers harvest only ripe tobacco which requires less curing
- consider reuse of wood in construction of curing barns
- Encourage farmers to construct curing barns with insulated walls and floors
- Encourage farmers to consider use of bricks in construction of curing barns other than tree
- Nothing has been done

- **Interview guide for the District KFS Officer and Staff**

Introduction

South Eastern Kenya University is carrying out a study on the Environmental Management Practices amongst tobacco farmers in Kuria West Sub-county, Migori County. This questionnaire is directed to find out the initiatives in place to prevent deforestation in the study area. Your open and genuine responses will be highly appreciated and treated with confidentiality. The information obtained will be used only for academic purposes.

1. Have you had problems of tobacco farmers cutting down trees from the forest to cure tobacco without seeking permits?

2. How do you control the haphazard cutting down of trees to cure tobacco by farmers?

Has this been successful?

3. Are there reforestation programs being promoted in the Sub-county and have they been successful?

4. What species do you recommend for reforestation in the region?

5. Are the seedlings for reforestation certified by a recognized body?

6. What are some of the initiatives by tobacco companies to control deforestation in the region?

Have they been successful?

7. Any other information you think will be relevant to the research