

THE INFLUENCE OF AGROFORESTRY PRACTICES ON ENVIRONMENT, A CASE OF
MAAI MAHIU, NAKURU COUNTY.

BY

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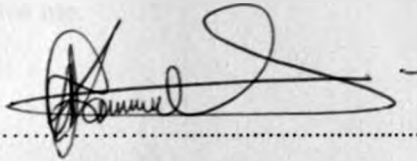
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DECLARATION

This research project report is my original work and has not been submitted for a degree in any other University.

Signed..........Date.....30/7/2012.....

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This research project report has been submitted with my approval as the University Supervisor.

Signed..........Date.....30.7.2012.....

Mr. Bwibo Adieri

Supervisor

DEDICATION

This research work is dedicated to dad and mum, Mr. and Mrs. Peter Kariuki, for their moral and financial support. To my best friend, Tom, for his encouragement and support during the course. To my siblings: Pamenas, Mercy, Catherine, and Faith for their encouragement and being there for me.

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ABBREVIATIONS AND ACRONYMS

ACC&S	African Christian Churches and Schools
ASALs	Arid and Semi – Arid Lands
CSD	Commission for Sustainable Development
NGO	Non- Governmental Organisation
WCED	World Commission on Environment and Development
MDGs	Millenium Development Goals
ICRAF	International Council for Research in Agroforestry
CGIAR	Consultative Group on International Agricultural Research

ABSTRACT

An estimated 1.2 billion rural people in the developing world currently practice and benefit from agroforestry. Agroforestry is the deliberate integration, in space or time, of woody perennials with herbaceous crops and/or animals on the same land management unit. With only 8 percent of the land capable of being cultivated for crops and 75 percent of the Kenyan workforce engaged in agriculture, Kenyan farmers face growing problems of soil erosion, deforestation, water pollution, and desertification.

In Maai Mahiu Division, the environment and the natural resources have been degraded and destroyed through deforestation, desertification, poor farming practices and overgrazing. The land has been left bare and susceptible to wind and soil erosion. Therefore, the research sought to find out the influence of agroforestry practices carried out in the area on the environment. The objective of the study was to find out the influence of alley cropping, wind breakers, Silvopasture, tree farming and live fences on the environment.

The methodology of the research highlights how the study was carried out. The study used survey design to collect quantifiable information from the sample. The target population was 500 people who were practicing agroforestry in Maai Mahiu Division. The sample population was 10% of the target population which was 50 respondents. The research tools for data collection used were questionnaires and observation schedules. The collected data was coded and analyzed using the STATA data analysis software.

The data has been presented in a descriptive form with the aid of tables and numerical data. The most common agroforestry practice is live fences with 100% and their major role is to provide security in the area and ornamental. The wind breakers are practiced by 96% and the main role is to break the wind as the area experiences very strong winds. Alley cropping follows with 68% and its role is to improve soil fertility. The Silvopasture practice had 56% and the role is to provide feeds for the livestock and to control soil erosion. The least practice in the area is tree farming where only 46% are practicing and their role is to provide firewood, timber and as a source of income. The major challenges with agroforestry in the area are inadequate rainfall causing the trees to dry and inadequate knowledge on the agroforestry practices, kinds and other vital benefits.

The study has made some recommendations which will help to curb some of the challenges in the area. First, the government in collaboration with other stakeholders should empower the communities in the area in order to promote tree farming so as to prevent deforestation and degradation of forests for firewood and timber. Secondly, the communities should be empowered on water harvesting structures during the rainy seasons for use during the dry seasons. Thirdly, the capacity of the communities should be built on agroforestry practices, kinds and the benefits so that the communities utilize all the practices effectively. Lastly, the extension services on agroforestry practices should be increase so that the farmers can be given hands on practical on how to carry out agroforestry.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Globally, there have been a lot of studies conducted based on remote sensing and geographical information systems which generated data that indicated that over 1 billion hectares (about 43%) of agricultural land have more than 10% tree cover, and these areas are home to almost a third of the 1.8 billion people who live on agricultural land, (Zomer, 2009; World Agroforestry Centre, 2009) and indeed, trees on farms are now seen as one of the most promising means known to better adapt farming systems to climate change, and to absorb carbon dioxide in the battle to moderate global warming worldwide, (World Agroforestry Centre, 2009).

An estimated 1.2 billion rural people in the developing world currently practice and benefit from agroforestry, (Garrity, 2006). For example 75- 85% of the fuel wood used in Indonesia, Java, Pakistan, the Philippines, Sri Lanka and Vietnam is harvested from farmland. In the arid parts of sub-Saharan Africa, over 7,500 species that grow in Silvopasture system are used as fodder and supply up to 50% of livestock feed. The use of nitrogen-fixing species including *Acacia Albida*, *Vitakaria paradoxa* and *Acacia Senegal* in parklands in West Africa is an example of traditional tree – based farming systems used to restore soil fertility, (Sadio, 2006).

Agenda 21, the blueprint for action into the 21st century adopted by world leaders meeting at the 1992 Rio Earth Summit, identifies agroforestry as one way of rehabilitating the degraded dry lands of the world. Agroforestry, one of several approaches for improving land use, is also frequently invoked as an answer to shortages of fuel wood, cash income, animal fodder and

building materials in sub-Saharan Africa, (Rocheleau, 1988). Agroforestry has been recognized to be of special importance as a carbon sequestration strategy because of its applicability in agricultural lands as well as in reforestation programs, (Cairns and Meganck 1994; Ruark, 2003).

Agroforestry is the deliberate integration, in space or time, of woody perennials with herbaceous crops and/or animals on the same land management unit, (Steppler and Nair, 1987). This can be simplified to the practice of growing trees with agricultural crops and/or livestock on the same piece of land, (Anderson, 1991). Agroforestry practices are major features of the land-use systems in the dry lands of Eastern and Central Africa. Trees are used for a variety of purposes in both cropped lands and in livestock grazing systems. Trees in the land and homestead find various domestic and commercial applications for both wood and non-wood products, (Jama and Zeila, 2000).

Agroforestry practices that integrate tree, crop, and animal components are emerging as part of an intensive land management approach focused on sustainable resource use and production within given economic, social, and environmental settings, (Rocheleau 1999, Lassoie and Buck 2000). Agroforestry systems are important sources of timber and fuel wood throughout the world in both developing and developed countries. For example, intercropping of trees and crops is practiced on 3 million hectares in China, (Sen, 1991) and in the United Kingdom; a range of timber/ cereal and timber/pasture systems has been profitable to farmers, (McAdam, Thomas and Willis 1999). Trees produced on farm are major sources of timber in Asia (e.g. China, India, and Pakistan), East Africa (e.g. Tanzania) and Southern Africa (e.g. Zambia), Increasing wood production on farms can take pressure off forests, which would otherwise result in their degradation.

Agroforestry practices nonetheless offer many advantages such as crop and livestock protection, soil and stream conservation and protection, diversification of agricultural revenues through the production of timber and non-timber forest products, promotion of biodiversity, landscape enhancement and carbon sequestration. In short, agroforestry can provide a wide range of environmental goods and services that are in keeping with the goal of integrated management of rural areas, (Baets, Gariépy and Vezina; 2007). Trees can improve soil fertility and soil moisture through increasing soil organic matter. Nitrogen-fixing leguminous trees and shrubs can be especially important to soil fertility where there is limited access to mineral fertilizers. Improved soil fertility tends to increase agricultural productivity and may allow more flexibility in the types of crops that can be grown. For example agroforestry systems in Africa have increased maize yields by 1.3 and 1.6 tons per hectare per year, (Sileshi, 2008).

According to FAO, 2010, the use of trees and shrubs in agricultural systems help to tackle the triple challenge of securing food security, mitigation and reducing the vulnerability and increasing the adaptability of agricultural systems to climate change. Trees in the farming system can help increase farm incomes and can help diversify production and thus spread risk against agricultural production or market failures. This will be increasingly important as impacts of climate change become more pronounced. Trees and shrubs can diminish the effects of extreme weather events, such as heavy rains, droughts and wind storms. They prevent erosion, stabilize soils, raise infiltration rates and halt land degradation. They can enrich biodiversity in the landscape and increase ecosystem stability.

1.2 Statement of the Problem

Maai Mahiu Division is an arid and semi-arid area in the Rift Valley. The environment and the natural resources have been degraded and destroyed through deforestation, desertification, poor farming practices and overgrazing. The land has therefore been left bare and susceptible to wind and soil erosion. On the other hand, when it rains the area experiences flash floods, trees are uprooted, and a lot of destruction is done on the environment. In May, 2012 during the long rains, the area of Longonot sub-location experienced a big crack which swallowed most rivers, road and reduced farming land. The land in Maai Mahiu is barren from tree removal for charcoal production and more generally because Kenya's forest cover reaches only 1.7 percent, far below the minimum UN recommended 10 percent.

According to the European journal of sciences (2009), human being is not only dependent on the physical environment for livelihood, but also in a number of ways they are capable of controlling and influencing the physical environment. However, in the quest to improve their standard of living and to fulfill their ever-increasing diversified and sophisticated needs, human use of the physical environment is often excessive and uncontrolled.

With only 8 percent of the land capable of being cultivated for crops and 75 percent of the Kenyan workforce engaged in agriculture, Kenyan farmers face growing problems of soil erosion, deforestation, water pollution, and desertification. Desertification and loss of biological diversity are some of the challenges of the 21st century, and Kenya is not spared by these phenomena. Therefore, due to the extensive degradation and deforestation of the Maai Mahiu Division, the researcher seeks to find out whether the agroforestry practices carried out by some individuals are contributing towards the environmental conservation measures in the area.

1.3 Overall Objective

- i. To determine the influence of agroforestry practices on environment in Maai Mahiu Division.

1.4 Research Objectives

The Objectives of this study are:

- i. To determine the influence of alley cropping on environment in Maai Mahiu Division.
- ii. To establish the influence of wind breakers on environment in Maai Mahiu Division.
- iii. To determine the influence of Silvopasture on environmental in Maai Mahiu Division.
- iv. To establish the influence of tree farming on environmental in Maai Mahiu Division.
- v. To determine the influence of live fences on environment in Maai Mahiu Division.

1.5 Research Questions

- i. What is the influence of alley cropping on environment in Maai Mahiu Division?
- ii. What is the influence of wind breakers on environment in Maai Mahiu Division?
- iii. What is the influence of Silvopasture on environment in Maai Mahiu Division?
- iv. What is the influence of tree farming on environment in Maai Mahiu Division?
- v. What is the influence of live fences on environment in Maai Mahiu Division?

1.7 Limitations of the study

- i. The target population was sparsely distributed which would have made the researcher spend a lot of time in travelling to collect data and the process would have taken longer than anticipated. This was countered by the researcher hiring one vehicle and motorbikes for the research assistants to aid their movement in the field.
- ii. The respondents might were not well knowledgeable on the agroforestry practices. The researcher made sure that the questionnaires was written in very simple language and the research assistants were well trained on how to administer the questionnaire for more explanation and probing further to ensure we got the information required.

1.8 Scope of the Study

The study covers Maai Mahiu Division which has four sub-locations namely; Munyu, Kijabe, Satellite and Longonot area. The total population of Maai Mahiu Division is 20,230 which comprises of 10,122 males and 10,108 women, (Population Census, 2009).

1.6 Purpose of the Study

The study sought to identify the influence of agroforestry practices on the environment in Maai Mahiu Division. The information compiled in the study will assist the government and other interested stakeholders on the various agroforestry practices carried out in the area and how it influences on the environment. This can be through development of policies, provision of the resources needed by the community and capacity building in the agroforestry practices.

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1.9 Assumptions of the Study

- i. The study assumed that all the respondents would answer all the questions correctly and truthfully. This was taken care of as the questionnaire response rate was 100% which was achieved through the use of well trained research assistants.

1.10 Operational definition of terms

Alley cropping: is planting rows of trees at wide spacing while a companion crop grows in the alleyways between the rows.

Wind breakers: are lines of trees or shrubs whose main aim is the reduction of wind speed and are planted at the edge of the farm in a line.

Silvopasture: is the intentional combination of trees, forage and livestock managed as a single integrated practice. In a typical silvopasture practice, perennial grasses and/or grass/legume mixes are planted between rows of widely spaced trees for livestock pasture.

Tree farming: This is the growing of trees only in large scale on a farm for own or commercial use.

Live fences: These are trees established all around the farm commonly to establish a fence around the homestead.

Environment: This refers to the total surrounding of the land that we live in terms of water, soils, air, the physical and man- made things.

1.11 Organization of the study

The study has been divided into five chapters. Chapter one is on the introduction of the study and carries the background of the study, statement of the problem, objectives, research questions, importance of the study, limitations, delimitations, scope, assumptions of the study, operational definitions of terms and organization of the study. Chapter two is on literature review and carries the introduction of the chapter, overview of agroforestry, alley cropping, wind breakers, Silvopasture, tree farming, live fences, gaps in agroforestry, theoretical framework, conceptual framework and ends with summary of the chapter. Chapter three is on research methodology and carries the introduction of the chapter, research design, target population, sample size and sampling procedure, methods of data collection, validity and reliability, methods of data analysis and the operational definition of variables.

Chapter four and five were written from the findings in the field. Chapter four is on data analysis, presentation and interpretation. It starts with the introduction, gives the questionnaire response rate, demographic information and the findings of each objective in form of frequency tables and a brief descriptive narration of the results and then the summary of the findings. Chapter five is the final chapter and it gives the summary of the findings, discussion, conclusion and the recommendations according to the results of the study. It is followed by the references, questionnaires, observation schedule and finally the appendices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature of other scholars on agroforestry. The agroforestry practices discussed are alley cropping, wind breakers, Silvopasture, tree farming and live fences. The literature has also identified some gaps in agroforestry practices. The conceptual framework explains the relationship between the independent, dependent, moderating and intervening variables. The theoretical framework explains the Malthusian theory in relation to environment and resource exploitation. The chapter ends with the summary of the discussions in the literature reviewed.

2.1 Overview of Agroforestry

Agroforestry is the use of trees and shrubs in agricultural crop and/or animal production and land management systems. It is estimated that trees occur on 46 percent of all agricultural lands and support 30 percent of all rural populations, (Zomer et al, 2009). Trees are used in many traditional and modern farming and rangeland systems. Trees on farms are particularly prevalent in Southeast Asia and Central and South America.

Agroforestry systems and practices come in many forms, including improved fallows, taungya (growing annual agricultural crops during the establishment of a forest plantation), home gardens, growing multipurpose trees and shrubs, boundary planting, farm woodlots, orchards, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, live

fences, trees on pasture and tree apiculture, (Nair, 1993 and Sinclair, 1999). Agroforestry provides cost-effective alternatives that can increase profits and meet environmental goals, (Brandle 1992, Clason 1995, Kurtz 2000).

Farmers have always grown trees on their land, often noting that this has beneficial effects for the soil and crop yields. This capacity of trees and other plants to restore soil fertility was utilized in African traditional agricultural systems based on shifting cultivation. It is also a well-known fact that the topsoil in forests is usually rich in nutrients and has a good structure. Scientists have concluded that the cycles of carbon and other nutrients under natural vegetation are relatively closed, i.e. there is little leakage out of the system. In spite of intensive research, however, much still remains to be discovered and verified with regard to the effects of trees on soil properties, (Tengnas, 1994).

Agroforestry systems tend to sequester much greater quantities of carbon than agricultural systems without trees. Planting trees in agricultural lands is relatively efficient and cost effective compared to other mitigation strategies, and provides a range of co-benefits important for improved farm family livelihoods and climate change adaptation, (FAO, 2010).

2.3 Alley Cropping

Snell T. (2000), defined alley cropping as growing of trees in rows or other configurations while growing crops between the tree rows. He adds that, "*High-value, short-duration crops can be grown in the alleys, while orchard or nut trees are growing. As the trees mature and require the entire growing space, the crops are not replanted in the alleys, and an orchard is established with little or no time or land out of production.*"

According to UMCA, 2010; alley cropping is planting rows of trees at wide spacing while a companion crop grows in the alleyways between the rows. Alley cropping can diversify farm income, improve crop production, and provide protection and conservation benefits to crops. Common examples of alley cropping plantings include wheat, corn, soybeans or hay planted in between rows of black walnut or pecan trees. Non-traditional or value-added specialty crops also may be incorporated for extra income. Trees selected for alley cropping may include valuable hardwood species, such as nut or fruit trees, or trees desirable for wood products.

The most suitable trees for alley cropping are leguminous ones (ones that fix nitrogen for the soil). Spacing between rows of trees should be at least 5m. The tree rows need to be weeded and pruned regularly. The trees cannot grow too tall otherwise they will compete with the crops for soil nutrients and light. The pruned leaves can be added to the soil to improve the soil fertility. In drier areas, this may not be a good approach or more space between trees and crops may be needed so that they do not compete too much for nutrients and water, (TIST, 2011).

2.4 Wind breakers

Windbreaks are narrow plantings of trees and shrubs, mainly tall woody species that form a linear barrier perpendicular to the prevailing winds; they protect cropland, pastureland, roads, farm buildings and houses from the harmful effects of wind and wind-blown sand and dust, (Snell 2000). Windbreaks are lines of trees or shrubs whose main aim is the reduction of wind speed. Well-designed windbreaks, i.e. ones that are not too dense, not only reduce wind speed but may also increase humidity and reduce water loss from the soil. The positive effect of a windbreak is said to be felt up to a distance 20 times the height of the trees in the windbreak, (Tengnas 1994).

Windbreakers also refer to planting wide strips of trees to provide a windbreak. This then protects crops from the oncoming wind. Plant large trees in the center, smaller trees for the next two rows and low shrubs, bushes and grasses on the outside. The advantage of windbreaks is that the farmer does not have to sacrifice an entire plot of land for trees. It only takes a strip of land, and the benefits can improve yields by 30% in some areas. Note that poorly planned windbreaks can damage crops more because it can channel the wind through gaps, (TIST, 2011).

Windbreaks provide benefits to downwind agricultural areas and dwellings and are present in some form on large numbers of farms and ranches today. A windbreak can be as simple as an overgrown fencerow or a few rows of trees left in place after a land clearing effort or forestry harvest. Many farmers and ranchers use natural boundaries of forest blocks and strips or patches of trees as windbreaks without planning or planting and still appreciate increased yields they provide to crops and livestock, (Snell, 2000). The energy required to moderate or maintain temperatures in buildings protected by windbreaks can be reduced by more than 20 percent when compared to unprotected structures, (Wenger, 1984).

UMCA, (2010) Windbreaks are planned and managed as part of a crop and/or livestock operation. Field windbreaks protect a variety of wind-sensitive crops; enhance production and conservation; control wind erosion; and increase bee pollination and limit spray drift of pesticides. Livestock windbreaks help reduce animal stress and mortality; reduce feed consumption; and help reduce visual impacts and odors. Windbreaks also may provide excellent wildlife habitat.

2.5 Silvopasture

Silvopasture is widely practiced in various forms. Silvopasture is the grazing of livestock and growing of trees on the same piece of land. Silvopasture can be developed by establishing trees in existing pastures or by establishing pastures within or under existing tree stands. Silvopasture systems can be arranged in unlimited combinations of livestock and tree components, enabling farmers to use all types of areas not easily farmed by more structured or mechanical methods, (Snell, 2000). This practice has received much research attention and is regarded as having promise for solving problems of declining soil fertility in situations where farmers cannot afford to use inorganic fertilizers at the recommended rates, (Tengnas, 1994).

UMCA, (2010) Silvopasture is the intentional combination of trees, forage and livestock managed as a single integrated practice. In a typical silvopasture practice, perennial grasses and/or grass/legume mixes are planted between rows of widely spaced trees for livestock pasture. The trees not only provide a long-term investment with nut crops or a timber harvest, but also provide animals shade in the summer and a windbreak in the winter. In turn, the forage base provides feed for cattle and other livestock. A Silvopasture practice diversifies farm income; can minimize the need for vegetation control; and can reduce hay and feeding costs for livestock and improve animal health.

Silvopasture is becoming an increasingly popular agroforestry practice in southern United States, (Clason and Sharrow 2000; Workman et al. 2003). Environmental benefits provided by this practice include water quality improvement, soil conservation, carbon sequestration, wildlife habitat protection, and aesthetics, (Alavalapati and Nair 2001; Workman et al. 2003).

Fodder trees have been traditionally used by farmers and pastoralists on extensive systems but fodder shrubs such as calliandra and leucaena are now being used in more intensive systems, increasing production and reducing the need for external feeds, (Franzel, Wambugu and Tuwei, 2003). Agroforestry systems for fodder are also profitable in developed countries. For example, in the northern agricultural region of Western Australia, using tagasaste (*Chamaecytisus proliferus*) has increased returns to farmers whose cattle formerly grazed on annual grasses and legumes, (Abadi *et al.*, 2003).

2.6 Tree Farming

Farm forestry can be regarded as almost synonymous to agroforestry, but it may also include large-scale forest production on private farms an activity that would fall outside the definition of agroforestry, (Tengnas, 1994). According to UMCA, 2009, forest farming, high-value specialty crops are grown under the protection of a forest canopy modified to provide the correct shade level. Crops like ginseng, shiitake mushrooms and decorative ferns are sold for medicinal, culinary and ornamental uses. Forest farming provides short-term income while high-quality trees are grown for wood products. Wildlife may find ideal habitat in a forest farming setting.

According to UMCA (2010), forest farming has high-value specialty crops grown under the protection of a forest canopy modified to provide the correct shade level. Crops like ginseng, truffles, shiitake mushrooms and decorative ferns are sold for medicinal, culinary and ornamental uses. Forest farming provides short-term income while high-quality trees are grown for wood products. Wildlife may find ideal habitat in a forest farming setting.

2.7 Live fence planting

Live fencing is a barrier made from plants that are still alive and growing. This can be anything from a simple row of Neem trees with barbed wire nailed to it, or it could be a multispecies system reinforced with dead thorny branches. Live fences have the advantage of regenerating after damage, creating valuable forest products, controlling erosion, and improving soil quality.

The three most common types of live fence include: live posts, thorny hedges and non-thorny hedges, (Kelly, 2010). Trees are often used for permanent boundary demarcation. Often certain species are associated with this function, e.g. *Croton megalocarpus* and *Commiphora zimmermannii* subsp. *emini* among the Kikuyu and *Markhamia lutea* among the Luo in Siaya, (Tengnas, 1994).

Tengnas (1994), states that the practice is relevant for most farming systems except on irrigation schemes and in most arid areas. Fences are more important where livestock graze and hedges elsewhere. Live fences are often combined with trees for wood production. Either some stems of the tree species can be allowed to grow large e.g cypress or trees of other species can be planted in the fence and allowed to grow well protected by the fence.

Fences and hedges are often multipurpose. Some of their uses are to provide shade and a windbreak for the compound, control movement of cattle, ornamental, provide protection for chickens against birds of prey, provide privacy, production of mulch, fruit, bee forage or wood, help in soil conservation. On the other hand, live fences require labour for maintenance, and if they are not maintained they lose their intended function and begin to compete with crops. *Caesalpinia decapetala* may be too thorny to have near houses as children may suffer. The latex

of *Euphorbia tirucalli* is very poisonous and dangerous for the eyes. Fences and hedges may harbour snakes, and some shrub species may turn into weeds, e.g. *Lantana camara*. *Thevetia peruviana* is also very poisonous, (Tengnas, 1994).

2.8 Gaps in Agroforestry Practices

Agroforestry in many regions is still constrained by local customs, institutions and national policies. Therefore, there is an urgent need for capacity building, extension and research programmes to screen and to match species with the right ecological zones and agricultural practices. There is also need to support and develop private public sector partnerships to develop and distribute agroforestry germplasm, like there is for the crops sector, (FAO, 2010).

2.9 Theoretical Framework

The theoretical framework explains on the Malthusian Theory in relation to land degradation, population and land resources. An important origin of all theories explaining the relationship between population growth and environmental degradation can be traced to the Malthusian model of population, resources and development (Malthus, 1987) and the 'classical' debate that followed. Malthus thought that the population rise would ultimately be limited by the means of subsistence. Population increases exponentially with the increase in the means of subsistence but sooner or later it is arrested due to the operation of the principle of diminishing returns to capital and labour. As such, output declines and the land resource is impoverished. Land degradation could thus implicitly be seen as a result of extreme levels of population pressure. At a later stage, Malthus incorporated Ricardo's view that the increasing population will necessarily cultivate on the extensive margin, incorporating more distant and poorer quality land, or, on the intensive

margin, resulting in lower returns to labour and capital, (Boserup, 1990; Tiffen, Mortimore and Gichuki, 1994).

The theory states that:

“Population increases ‘geometrically’ or exponentially and that subsistence increases arithmetically. Thus, population increases along the order of 1, 2, 4, 8, 16, 32..., whereas subsistence limps along at the rate of 1, 2, 3, 4..... .”

2.10 Malthusian Theory on Land degradation

Land degradation can come about through a variety of processes--deforestation, desertification through poor agricultural techniques, amongst others. According to neo-Malthusians, the increasing number of people will increase land degradation, because more people consume more trees (deforestation) and more food (agriculture). Thus, the solution is to limit the number of people/consumers/polluters.

Scientific evidence: As mentioned earlier, land degradation is thought to be caused by two different sources: deforestation and desertification through poor land management. The FAO’s description of the issue begins by noting that:-

Dry lands cover about 30 percent of the world's terrestrial surface and are home to 900 million people. Defined as arid, semi-arid and dry sub-humid areas, they are among the world's most fragile ecosystems. Over centuries, their inhabitants - including some of the world's poorest populations - have developed complex food production systems to minimize the threat of recurring droughts and desertification.

Various factors contribute to widespread natural resource degradation in dry areas: climatic variation, inappropriate land use and agricultural practices, increasing population density, economic pressures and changes in land tenure patterns. For example, degradation of tree and shrub formations and overexploitation of forests are among the major causes of soil degradation in the dry tropics. FAO data indicates that the rate of deforestation in these areas is almost one percent a year.

According to the World Bank, the annual amount of deforestation for the world was 101,724 square kilometers in the period 1990-1995. A disaggregation by country reveals that many countries (such as the U.S. and many EU nations) actually had negative rates of deforestation: the U.S. 'deforested' -5,886 square kilometers; the U.K 'deforested' -128 square kilometers; France, -1,608 s. In contrast to those numbers, Indonesia deforested 10,844 square kilometers, Brazil 25,544 square kilometers etc.

With regard to the problem of desertification, the FAO points out that this form of land degradation can be a problem of too much water as of too little water. Waterlogged land can develop salt deposits, rendering the land unusable. However, both are the result of poor management.

2.10.1 Neo- Malthusian theory on Land Resource

Scientific Evidence: In 1968, Garrett Hardin's "Tragedy of the Commons" contended that users of a common resource (water, land, air) will inevitably destroy the very resource upon which they depend. A classic neo-Malthusian argument for natural limits, Hardin's article was seminal to the population-resources debate. Recently, however, scientists have countered Hardin's case

by pointing out that methods can be developed that will allow for sustainable use of common resources. Elinor Ostrom *et al* argue that:-

"Although tragedies have undoubtedly occurred, it is also obvious that for thousands of years people have self-organized to manage common-pool resources, and users often do devise long-term, sustainable institutions for governing these resources. It is time for a reassessment of the generality of the theory that has grown out of Hardin's original paper. ... An important lesson from the empirical studies of sustainable resources is that more solutions exist than Hardin proposed.

Ostrom *et al* go on to argue that common-pool resources can be managed in a variety of ways, utilizing both local collective agreement and governmental regulations to one degree or another. They found that community based regulation works most effectively for local or regional resources, but that such solutions would need to be altered for global common-pool resources such as the oceans and air. This finding was confirmed by a second group of scientists, who also pointed out that collaboration between scientists and local enables the creation of sustainable environments for both humans and wildlife, which can also be an economic boon for the community. "Community-based natural resource management accepts that much of the state of ecosystems rests with local people and, therefore, the technology that can contribute to the sustainable use of natural resources is best used by local people."

2.11 Conceptual Framework

The conceptual framework shown below indicates the relationship between the dependent variables which is environmental and the independent variables which are: alley cropping, wind

breakers, Silvopasture, tree farming and live fences practices in Maai Mahiu Division. The relationship between the independent variables is also affected by the moderating factors such as government policies and intervening factors such as the attitude of the community on environment.

Agroforestry practices such as alley cropping, wind breakers, tree farming, Silvopasture and live fences if carried out well contribute to environmental conservation and other benefits like income generation. Different practices have different impacts on the environment and therefore if all are integrated in every house hold, the effects on the environment would be effective and would reduce desertification and environmental degradation greatly.

It is important to note that: when promoting the implementation of agroforestry practices, the communities involved should be aware of their benefits in order to appreciate and embrace the agroforestry practices. In the implementation of agroforestry practice, there are several challenges faced in mitigating environmental degradation. Some of the challenges include drought, floods, lack of resources, inadequate knowledge and skills in carrying out the practices. The community's perception also determines the effort put to reduce environmental degradation. If there is a passion and willingness to restore the environment then positive results will be archived unlike when there is ignorance and lack of interest.

Independent variables

Moderating variable

Dependent variable

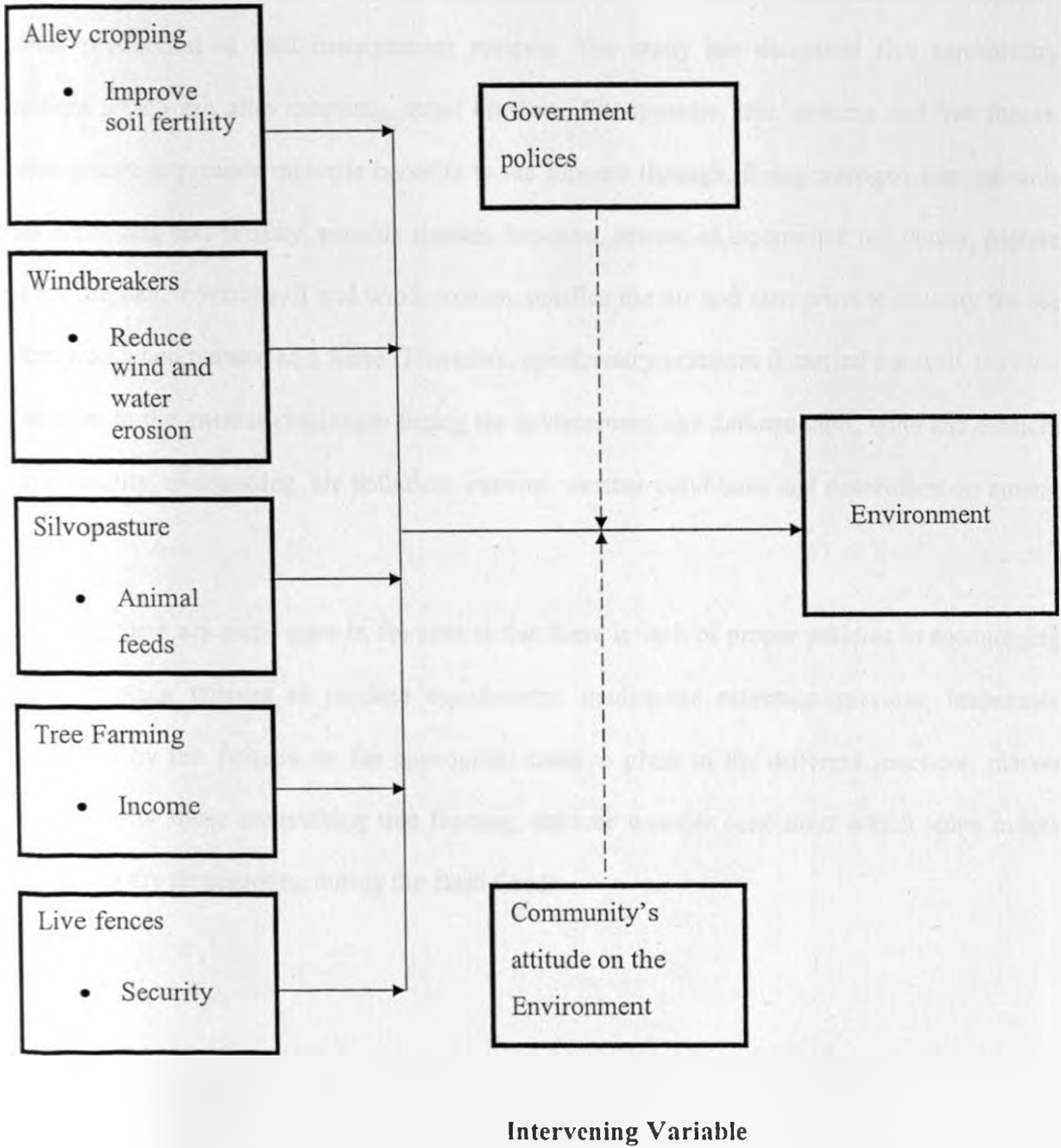


Figure 1: Conceptual Framework

2.12 Summary of the Chapter

Agroforestry has been agreed by most scholars as use of trees and shrubs in agricultural crop and animal production in land management systems. The study has discussed five agroforestry practices which are alley cropping, wind breakers, Silvopasture, tree farming and live fences. These practices provide multiple benefits to the farmers through, fixing nitrogen into the soils thus improving soil fertility, provide timber, firewood, source of income for the family, pasture for the animals, control soil and wind erosion, purifies the air and also provide security for the homestead when planted as a fence. Therefore, agroforestry practices if carried out well, they are a solution to the various challenges facing the environment like deforestation, wind and erosion, soil infertility, overgrazing, air pollution, extreme weather conditions and desertification among others.

However, there are some gaps in the area in that there is lack of proper policies in encouraging and motivating farmers to practice agroforestry, inadequate extension services, inadequate knowledge by the farmers on the appropriate trees to plant in the different practices, market constraints for those undertaking tree farming, extreme weather conditions which either makes the trees to dry or uprooting during the flash floods.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The research was carried out in Maai Mahiu Division. The research design process involved constructing of questionnaires, observation guide, questionnaire pre-testing, preparation of transmittal letters to accompany the questionnaires, booking appointments and field visits to collect data. The collected data was then analyzed and reported in chapter 4.

3.2 Research Design

The study used a survey research design. A survey is an attempt to collect data from members of a population in order to determine the current status of that population with respect to one or more variables, (Gay 1983 as quoted by Mugenda and Mugenda, 2003). Survey research can also be defined as a self – report study which requires the collection of quantifiable information from the sample. It is descriptive, exploratory and could involve advanced statistical analysis, (Mugenda and Mugenda, 2003).

3.3 Target Population

The target population was 500 people who were undertaking agroforestry practices in Maai Mahiu Division, (ACC&S, 2011).

3.4 Sample size and sampling Procedure

3.4.1 Sample size

The sample size was 50 respondents who were undertaking agroforestry practices. The researcher used 10% of the target population which was 500 respondents to get the sample. Gay, 1981 as quoted by Mugenda & Mugenda, 2003, suggests that for descriptive studies, 10% of the accessible population is enough for sample size selection.

3.4.2 Sampling Procedure

Sampling is the process of selecting a number of individuals for a study in such a way that the individuals selected represent the large group from which they were selected. (Mugenda & Mugenda, 2003). Maai Mahiu Division has 4 sub-locations whereby the sample size of 50 respondents was divided among the sub – division to get the sample size in each location. Then from each sub - location, snow ball sampling technique was used till the defined sample size was reached. Snowball sampling technique is where the researcher identified a small number of individuals who have the required characteristics. These people were then used as informants to identify others who qualify for inclusion in the sample.

The sample size per sub - location is shown in Table 3.1:

Table 3.1: A table showing sample size per sub - location

Location	Population per sub-location	Sample Size
Kijabe Sub-location	50	13
Satellite Sub-location	50	13
Longonot Sub-location	50	12
Munyu- Sub-location	50	12
Totals		50

3.5 Validity and Reliability

3.5.1 Reliability

According to Mugenda and Mugenda 2003, reliability refers to a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Therefore, the researcher used the test-retest method of assessing reliability of data by administering the same instrument twice to the same group of subject. The questionnaires and observation schedules were administered using the same procedure where the researcher correlated the scores from both testing periods and found the coefficient of reliability to be positive which qualified the instrument as reliable.

3.5.2 Validity

Validity refers to the accuracy and meaningfulness of inferences, which are based on the research results (Mugenda & Mugenda, 2003). Validity, therefore, has to do with how accurately the data obtained in the study represents the variables of the study. If such data is a true reflection of the variables, then inferences based on such data will be accurate and meaningful. Prior to using the research instrument, the content validity of the instruments was determined by

the researcher through discussing the items in the instrument with the supervisor and putting the same under peer consideration (Robson, 2002).

3.6 Methods of Data Collection

Data collection was done using research instruments such as questionnaires interviews and observation schedules. Questionnaires are commonly used to obtain important information about the population. Each item in the questionnaire is developed to address a specific objective or hypothesis of the study (Mugenda & Mugenda, 2003). According to Mugenda and Mugenda (2003), an interview is an oral administration of a questionnaire or an interview schedule. Interviews are therefore, face to face encounters. An observation schedule was used to guide the characteristics of agroforestry in order to know where to administer the questionnaires during the data collection.

Data collection was carried out for a period of one week. This was through the help of research assistants who were well trained on the questionnaire interview administration to ensure familiarity. The questionnaires were accompanied by the observation schedules which guided the researcher and the research assistants on the characteristics of agroforestry they were on look out for. All the filled questionnaires were collected and submitted to the researcher every day of the field work.

3.7 Methods of Data Analysis

The questionnaires and observation schedules were coded accurately. Coding refers to the process of assigning numbers to subjects' responses (Mugenda and Mugenda, 2003). The coded responses were then analyzed using the STATA data analysis software. The data is usually stored in raw form and this makes it easy to attempt all forms of informative and relevant computations. The data was then presented in a descriptive narration with an aid of tables and numerical data. Data stored in STATA is easy to manipulate through coding and recoding.

3.8 Operational definition of variables

Table 3.2 shows the operational definition of variables.

Table 3.2: Operational definition of variables

Objectives	Variables	Indicators	Measurements	Measurement Scale	Study Design	Type of Analysis	Tool of Analysis
1.To find out the influence of alley cropping on environmental in Maai Mahiu Division	Independent Variable Alley cropping	Trees planted with other crops	Improved soil fertility Increased yields	Ratio scale	Descriptive Survey	-Central tendency	STATA Analysis
	Dependent Variable Environmental	Afforestation Soil conservation Soil fertility			Descriptive survey	-Central tendency	STATA Analysis
2.To find out the influence of wind breakers on environment in Maai Mahiu Division	Independent Variable Wind breakers	Trees planted on the edges of the farm	Kinds of trees planted on the edges	Ratio scale	Descriptive survey	-Central tendency	STATA Analysis
	Dependent Variable Environmental	Wind erosion Soil erosion Timber	Reduced environmental degradation	Ratio	Descriptive survey	-Central tendency	STATA Analysis

3. To find out the influence of Silvopasture on environment in Maai Mahiu Division	Independent Variable Silvopasture	Fodder or trees used as pasture	Types of animal feeds planted	Ratio	Descriptive survey	-Central tendency	STATA Analysis
	Dependent Variable Environmental	Animal feeds	Zero grazing practices	Ratio	Descriptive survey	-Central tendency	STATA Analysis
4. To find out the influence of tree farming on environment in Maai Mahiu Division	Independent Variable Tree farming	No of trees planted	Availability of timber / wood	Ratio	Descriptive survey	-Central tendency	STATA Analysis
	Dependent Variable Environmental	Purification of the air Soil conservation Increased forest cover	Availability of firewood	Ratio	Descriptive survey	-Central tendency	STATA Analysis
5. To find out the influence of live fences on the environment in Maai Mahiu Division	Independent Variable Live fences	Presence of a live fence / hedges	Types of tree / shrubs used as fence	Ratio scale	Descriptive survey	-Central tendency	STATA Analysis
	Dependent Variable Environment	Security Firewood			Descriptive survey	-Central tendency	STATA Analysis

3.9 Summary of the Chapter

The study used survey research design. The target population was 500 people practicing agroforestry. A 10% sample size was selected from the target population to get 50 respondents. The 50 respondents were selected from the 4 sub- locations in the Division. Data was collected through use of questionnaires and observation schedules. The questionnaires and the observation schedules were re-tested through a pilot study before actual data collection to a population with similar characteristics to the actual population. The collected data was analyzed through STATA data analysis software and is presented a descriptive form with aid of frequency tables and numerical data.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter covers data analysis, presentation and interpretation of the results. It is divided into the following sections: introduction, questionnaire response rate, demographic information, and the findings on the various types of agroforestry practices which include alley cropping, wind breakers, Silvopasture, tree farming and live fences. The information has been presented in form of narration with aid of tables and numerical figures for clarification. The chapter also gives conclusion of the study, recommendations and ends with a summary.

4.2 Questionnaire response rate

The questionnaire response rate was 100% which means that all the 50 respondents answered the 50 questionnaires. The 100% response rate was because the questionnaires were administered by trained research assistants through interviews in the four locations in Maai Mahiu Division.

4.3 Demographic information

This section presents, discusses and interprets the findings on the respondents' location, gender, age, level of education, duration of stay in Maai Mahiu, total arable land owned and the type of land ownership.

4.3.1 Distribution of the respondents by Sub - location

Table 4.1 shows the distribution of the respondents in the four sub-locations in Maai Mahiu Division.

Table 4.1: Distribution of the respondents by Sub - location

Sub-Location	Frequency	Percentage	Cum. Percentage
Munyu	12	24	24
Satellite	13	26	50
Kijabe	13	26	76
Longonot	12	24	100
Totals	50	100	

In Munyu and Longonot sub- locations, the respondents were 24% each while in Satellite and Kijabe locations, the respondents were 26% each.

4.3.2 Distribution of the respondents by gender

Table 4.2 shows the gender of the respondents that were interviewed.

Table 4.2: Distribution of the respondents by gender

Gender	Frequency	Percentage	Cum. Percentage
Male	21	42	42
Female	29	58	100
Totals	50	100	

According to the results, the females who were interviewed were more than the males.

4.3.3 Distribution of the respondents by age

Table 4.3 shows the age of the respondents who were interviewed in the study.

Table 4.3: Distribution of the respondents by age

Age	Freq.	Percentage
23 -40	19	38
41 – 58	14	28
59 – 76	13	26
77 – 86	4	8
Totals	50	100

According to the results, the majority of the respondents lied in the age brackets of 23 to 40. This means that the majority of those practicing agroforestry practices are the youth.

4.3.4 Distribution of the respondents by education

Table 4.4 shows the education levels of the respondents interviewed in Maai Mahiu Division.

Table 4.4: Distribution of the respondents by education

Education	Frequency	Percentage	Cum. Percentage
None	7	14	14
Primary	29	58	72
Secondary	10	20	92
College	3	6	98
University	1	2	100
Total	50	100	

The majority of the respondents are illiterate because those without any education and those who have gone up to primary education level form 72%.

4.3.5 Distribution of the respondents by duration of stay

Table 4.5 shows the period of which the respondents have stayed in Maai Mahiu Division.

Table 4.5: Distribution of the respondents by duration of stay

Duration in years	Freq.	Percentage
5 – 20	21	42
21 – 40	19	38
41 – 72	10	20
Totals	50	100

The majority of the respondents have stayed in Maai Mahiu for a minimum period of 5 years and within 20 years.

4.3.6 Distribution of total arable land in acres

Table 4.6 shows the total arable land owned by each respondent in acres.

Table 4.6: Distribution of total arable land in acres

Land in acres	Freq.	Percentage
0.25 – 2	16	32
2.5 - 5	22	44
5.5 – 10	10	20
11 – 15	2	4
Totals	50	100

The majority of the respondents total land owned is between 2.5 to 5 acres.

4.3.7 Distribution of the respondents by land ownership type

Table 4.7 shows the mode of land ownership by the respondents in Maai Mahiu Division.

Table 4.7: Distribution of the respondents by land ownership type

Land ownership	Frequency	Percentage	Cum. Percentage
Bought	21	42	42
Inherit	8	56	98
Rent / Hire	1	2	100
Total	50	100	

The majority of the respondents own their land through buying and inheritance which forms 98% of the total sample population.

4.4 Distribution of the respondents practicing alley cropping

Table 4.8 shows the total number of respondents practicing alley cropping and those who are not practicing.

Table 4.8: Distribution of the respondents practicing alley cropping

Alley cropping	Frequency	Percentage	Cum. Percentage
Yes	34	68	68
No	16	32	100
Total	50	100	

The results show that more than half of the population is carrying out alley cropping and only a few are not practicing.

4.4.1 Distribution of the kinds of alley cropping trees planted

Table 4.9 shows the different kinds of trees that are planted under alley cropping practice.

Table 4.9: Distribution of the kinds of alley cropping trees planted

Alley cropping kinds	Frequency	Percentage	Cum. Percentage
Acacia	10	20	20
Gravelia	20	40	60
Croton	1	2	62
Cedar	3	6	68
Fruit trees	4	8	76
Casolina	5	10	86
Others	7	14	100
Total	50	100	

The common kinds of trees planted for alley cropping are: gravelia with the highest percentage, followed by acacia trees and then casolina. The fruit trees, cedar, croton and other species have been planted by few people and thus not popular in the area.

4.4.2 Distribution of the benefits of alley cropping on environment

Table 4.10 shows the benefits of alley cropping practice to the environment.

Table 4.10: Distribution of the benefits of alley cropping on environment

Benefits	Frequency	Percentage
Improve soil fertility	12	24
Source of firewood	10	20
Control soil erosion	9	18
Provide shade	8	16
Source of timber	6	12
Others	5	10
Totals	50	100

The major benefit of alley cropping on the environment is to improve soil fertility, followed by source of firewood, and the controlling soil erosion. Providing shade, source of timber and other benefits constitute the minor benefits accrued from the practice.

4.4.3 Distribution of alley cropping challenges

Table 4.11 shows the challenges that the respondents practicing alley cropping face.

Table 4.11: Distribution of alley cropping challenges

Challenges	Frequency	Percentage
Lack of knowledge	11	22
Inadequate resources	2	4
Inadequate ext. services	4	8
Inadequate rainfall	17	34
Pests and diseases	12	24
Competition of crops with trees	4	8
Totals	50	100

The major challenges in the area are inadequate rainfall, infestation of pests and diseases and inadequate knowledge of agroforestry practices.

4.5 Distribution of the respondents with wind breakers

Table 4.12 shows the respondents carrying out the practice of wind breakers.

Table 4.12: Distribution of the respondents with wind breakers

Wind breakers	Frequency	Percentage	Cum. Percentage
Yes	48	96	96
No	2	4	100
Total	50	100	

4.5.1 Distribution of the kinds of wind breakers planted

Table 4.13 shows the different kinds of trees planted as wind breakers in Maai Mahú Division.

Table 4.13: Distribution of the kinds of wind breakers planted

Wind breakers Kinds	Frequency	Percentage	Cum. Percentage
Gravelia	19	38	38
Acacia	3	6	44
Croton	6	12	56
Eucalyptus	10	20	76
Cypress	4	8	84
Others	8	16	100
Total	50	100	

The common trees planted as wind breakers are gravelia with the highest percentage, followed by eucalyptus, croton and the other species with small percentages.

4.5.2 Distribution of wind breakers benefits to the environment

Table 4.14 shows the benefits that the respondents get from the wind breakers.

Table 4.14: Distribution of wind breakers benefits to the environment

Benefits	Frequency	Percentage
Break the wind	15	30
Control soil erosion	6	12
Source of timber	7	14
Source of firewood	11	22
Source of income	2	4
Purification of the air	8	16
Others	1	2
Total	50	100

The major benefit of wind breakers in the region is to break the speed of the wind. The other benefits are as source of firewood, purification of the air, source of timber and controlling soil erosion as minor benefits.

4.5.3 Distribution of wind breakers' challenges on the environment

Table 4.15 shows the challenges that the respondents get from the wind breakers.

Table 4.15: Distribution of wind breakers' challenges on the environment

Challenges	Frequency	Percentage	Cum. Percentage
Lack of knowledge	10	20	20
Inadequate resources	5	9	29
Inadequate ext. services	7	15	44
Inadequate rainfall	23	45	89
Infestation of pests and disease	3	6	95
Others	2	5	100
Total	50	100	

The major challenge of wind breakers is inadequate rainfall in the area which causes the planted trees to dry. This is followed by lack of knowledge on agroforestry practices and inadequate extension services on agroforestry.

4.6 Distribution of the respondents with Silvopasture

Table 4.16 shows the percentage of respondents practicing and those not practicing Silvopasture.

Table 4.16: Distribution of the respondents with Silvopasture

Silvopasture	Frequency	Percentage	Cum. Percentage
Yes	28	56	56
No	22	44	100
Total	50	100	

The results show that only 56 % of the respondents are carrying out Silvopasture practice.

4.6.1 Distribution of the kinds of Silvopasture practiced

Table 4.17 shows the different kinds of trees or fodder crops planted for Silvopasture.

Table 4.17: Distribution of the kinds of Silvopasture practiced

Silvopasture kinds	Frequency	Percentage	Cum. Percentage
Napier grass	36	72	72
Lucern	2	4	76
Star grass	2	4	80
Others	10	20	100
Total	50	100	

The results show that the common kind of Silvopasture fodder crop is Napier grass with 72%.

4.6.2 Distribution of Silvopasture benefits

Table 4.18 shows the benefits of the Silvopasture practice to the environment.

Table 4.18: Distribution of Silvopasture benefits

Benefits	Frequency	Percentage	Cum. Percentage
Livestock feeds	26	52	52
Control soil erosion	21	43	95
Shade for livestock	3	5	100
Total	50	100	

The major benefit of Silvopasture practice is source of feeds to the livestock followed by controlling soil erosion.

4.6.3 Distribution of Silvopasture challenges

Table 4.19 shows the challenges that the respondents get from Silvopasture practice.

Table 4.19: Distribution of Silvopasture challenges

Challenges	Frequency	Percentage	Cum. Percentage
Lack of knowledge	13	27	27
Inadequate resources	5	10	37
Inadequate ext. services	5	10	47
Inadequate rainfall	21	43	90
Pests & diseases	4	7	97
Others	2	3	100
Total	50	100	

The major challenge is inadequate rainfall in the area causing the trees and the fodder crops planted to dry followed by lack of knowledge on the agroforestry practices in Silvopasture.

4.7 Distribution of the respondents with tree farming

Table 4.20 shows the percentage of respondents practicing tree farming practice.

Table 4.20: Distribution of respondents with tree farming

Tree farming	Frequency	Percentage	Cum. Percentage
Yes	23	46	46
No	27	54	100
Total	50	100	

The results show that less than half of the respondents are practicing agroforestry with 46%.

4.7.1 Distribution of the kinds of tree farming

Table 4.21 shows the different kinds of trees planted as a tree farming practice.

Table 4.21: Distribution of the kinds of tree farming

Kinds	Frequency	Percentage	Cum. Percentage
Eucalyptus	18	36	36
Acacia	8	16	52
Gravelia	11	22	74
Cypress	4	8	82
Others	9	18	100
Total	50	100	

The most common trees planted are eucalyptus, followed by gravelia, acacia and the least is cypress.

4.7.2 Distribution of tree farming benefits

Table 4.22 shows the benefits of tree farming practice on the environment.

Table 4.22: Distribution of tree farming benefits

Benefits	Frequency	Percentage	Cum. Percentage
Source of timber	15	30	30
Source of firewood	18	37	67
Source of income	11	22	89
Mulch used as manure	2	3	92
Others	4	8	100
Total	50	100	

The major benefit of tree farming is as source of firewood, followed by source of timber and then source of income.

4.7.2 Distribution of tree farming challenges

Table 4.23 shows the challenges experienced in Maai Mahiu Division with tree farming practice.

Table 4.23: Distribution of tree farming challenges

Challenges	Frequency	Percentage	Cum. Percentage
Lack of knowledge	4	7	7
Inadequate resources	5	10	17
Inadequate ext. services	7	15	32
Inadequate rainfall	20	41	73
Pests & diseases	4	7	80
Poor market prices	5	10	90
Others	5	10	100
Total	50	100	

The major challenges experienced are inadequate rainfall in the area causing the trees to dry followed by inadequate extension services on agroforestry practices in the area.

4.7 Distribution of the respondents with live fences

Table 4.24 shows the percentage of respondents with the live fences.

Table 4.24: Distribution of respondents with live fences

Live fences	Frequency	Percentage	Cum. Percentage
Yes	50	100	100
Total	50	100	

The results of the study show that the live fence practice was being carried out by all the respondents who were interviewed.

4.7.1 Distribution of the kinds of live fences

Table 4.25 shows the different kinds of live fences planted in Maai Mahiu Division.

Table 4.25: Distribution of the kinds of live fences

Kinds	Frequency	Percentage	Cum. Percentage
Kei apple	26	52	52
Euphorbia	9	18	70
Kei apple & Euphorbia	7	14	84
Kei apple & sisal	2	4	88
Cyprus	2	4	92
Sisal	2	4	96
Combinations	2	4	100
Total	50	100	

The most common kinds are kei apple, followed by euphorbia and the combination of kei apple and euphorbia.

4.7.2 Distribution of live fences' benefits on the environment

Table 4.26 shows the benefits of live fences on the environment.

Table 4.26: Distribution of live fences' benefits on the environment

Benefits	Frequency	Percentage	Cum. Percentage
Security in the compound	23	46	46
Ornamental	18	37	83
Source of firewood(pruned)	6	12	95
Others	3	5	100
Total	50	100	

The major benefit of the live fences is to provide security to the homestead compound followed by ornamental aspect.

4.7.2 Distribution of live fences' challenges on the environment

Table 4.27 shows the challenges of live fences on the environment in Maai Mahiu Division.

Table 4.27: Distribution of live fences' challenges on environment

Challenges	Frequency	Percentage	Cum. Percentage
Take long to mature	20	40	40
Inadequate resources	2	4	44
Inadequate rainfall	11	22	66
Pests & diseases	2	4	70
Others	15	30	100
Total	50	100	

The major challenge experienced with the live fences is that they take too long to mature followed by inadequate rainfall in the area which causes the fences to dry.

4.8 Summary of the chapter

The chapter has presented the data analyzed from the field and presented it in a narrative form with the aid of frequency percentage tables and numerical figures. The data has been presented in the order of the questionnaire design. The first section is on the demographic information and then followed by the various sections of agroforestry practices outlined. Each section contains an interpretation of the data contained in the tables.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, DISCUSSIONS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter contains the summary of the findings; the discussions of the findings which are based on each of the stated objectives, conclusion and recommendations based on the findings of the study. The chapter also highlights the suggestions for further studies.

5.2 Summary of the findings

According to the study, the majority of the respondents were females with 58% females. The majority of the respondents' ages lie in the age bracket of 23 to 40 which represent the youth. The education level of the respondents was found to be low because those without any education and those with primary education comprised 72% of the total population interviewed. This means that the illiteracy level is quite high. The duration that the respondents have stayed in Maai Mahiu is approximately within 5 to 20 years. The minimum duration was found to be 5 years and the maximum is 72 years. The total size of arable land owned is 2.5 to 5 acres.

The most common agroforestry practice in Maai Mahiu is live fences, followed by wind breakers, alley cropping, silvopasture and the least is tree farming with. The kinds of trees planted for alley cropping are mainly gravelia and acacia with the major role being to improve soil fertility and as a source of firewood. The wind breaker trees planted are mainly gravelia with and eucalyptus and their major role is to break the strong winds in the area. The silvopasture fodder commonly planted is Napier grass and the major benefit is to provide feeds for the

livestock and to control soil erosion. The tree farming kinds are mainly eucalyptus and gravelia and their major role is to provide firewood and source of timber. The most common live fences in Maai Mahiu are kei apple and euphorbia which are a source of security in the homestead and ornamental.

5.3 Discussion of the findings

The key findings have been discussed below as per the stated objectives of the study and in relation to literature review:

5.3.1 The influence of alley cropping on environment in Maai Mahiu Division

The respondents practicing alley cropping were 68%. This shows that majority of the respondents are aware about alley cropping and are practicing it. The trees planted are gravelia and acacia and their main benefits to the environment are to improving soil fertility, source of firewood and to control soil erosion. The respondents have found that alley cropping helps to improve soil fertility through fixing nitrogen in to the soil. The challenges faced with alley cropping are: inadequate rainfall causing the trees to dry, infestation of pests and diseases and lack of knowledge on the appropriate trees to plant with crops.

The study agrees with most scholars that the major role of alley cropping is to improve soil fertility. TIST, 2011 suggests that the most suitable trees for alley cropping are leguminous ones as they fix nitrogen into the soil thus improving soil fertility.

5.3.2 The influence of wind breakers on environment in Maai Mahiu Division

The study found out that 96% of the respondents have planted wind breakers. This could be attributed to the fact that Maai Mahiu division is very windy and therefore most people tend to plant wind breaker trees to break the wind. The common kinds of wind breaker trees planted are gravelia, eucalyptus and croton. The benefits of the wind breakers are to break the wind, source of firewood and purification of the air. The challenges of wind breakers are inadequate rainfall causing the trees to dry, lack of knowledge on the trees to plant and inadequate extension services.

The study results agrees with Snell, 2000, that the wind breakers major role is to protect cropland, Pastureland, roads, farm lands and houses from the harmful effects of wind and wind-blown sand and dust. Despite the use of wind breakers in reducing the harmful effects of wind, the respondents acknowledged that they use them for firewood and to purify the air.

5.3.3 The influence of Silvopasture on environment in Maai Mahiu Division

The respondents practicing Silvopasture was found to be 56%. This is not a common practice in the area as compared to other practices because the people in Maai Mahiu practice free range grazing and therefore do not plant feeds for their livestock. The main type of Silvopasture practiced is Napier grass. The major benefits are to provide livestock feeds and to control soil erosion. The challenges experienced are inadequate rainfall and lack of knowledge on other kinds of Silvopasture fodder and shrubs to plant.

Scholars like Tengnas, 1994 emphasis that the Silvopasture practice has received much attention and is regarded as halving the promise of solving problems of declining soil fertility in situations

where farmers cannot afford to use inorganic fertilizers at the recommended rates. However, the role of the practice in improving soil fertility to Maai Mahiu community is unknown. The only major benefits of the practice is source of feeds for livestock and controlling soil erosion as stated by scholars like UMCA 2012, and Franzel, Wambugu and Tuwei,2003.

5.3.4 The influence of tree farming on environment in Maai Mahiu Division

The respondents who practice tree farming are 46%. From the results, most of the respondents are not practicing tree farming in Maai Mahiu division. The kinds of trees planted are mainly eucalyptus and gravelia. The main benefits of tree farming are as source of firewood, timber and income. The challenges that the respondents face with tree farming are: inadequate rainfall and inadequate extension services.

According to Tegnás 1994, forest farming is the large scale forest production on private farms carried out for commercial purposes. However, the study found that tree farming can also be carried on a small scale on private farms for the production of firewood and timber for domestic purposes which 46% of the respondents are doing. This is important as the farmers get to learn the importance of trees for their various uses and this helps to protect the forests from deforestation for purposes of firewood and timber.

5.3.5 The influence of live fences on environment in Maai Mahiu Division

The respondents interviewed all had live fences with the results giving 100%. This is the most common practice which was found in all the homesteads visited. This means that the population is more familiar with this practice as compared to the other practices discussed. The types of live fences planted are kei apple, euphorbia and a combination of kei apple and euphorbia. The

benefits of the live fences are to provide security in the compound and ornamental. The challenges faced with the life fences are that they take long to mature and inadequate rainfall which causes the fences to dry.

The study agrees with Kelly, 2010 and Tengnas, 1994 that live fences provide permanent boundary demarcation which provides security to the homestead. They also add that they can be used for valuable forests products, controlling erosion and improving soil fertility are some of the benefits that the study did not find on the ground.

5.4 Conclusion

From the study, agroforestry practices have a positive influence on the environment because of the many benefits derived. The major role of alley cropping practice is to improve soil fertility, source of firewood and control soil erosion. The trees recommended for this practice are leguminous as they fix nitrogen into the soil and make it rich. The wind breakers main role is to reduce the speed of the wind and the harmful effects of the wind and windblown sand and dust. The Silvopasture benefit to the environment is to provide feeds for the livestock and to control soil erosion. This is a good practice of controlling soil erosion if the community can adopt zero grazing practice and the Napier grass. Tree farming practice had been adopted by few people in Maai Mahiu on a small scale practice for purposes of firewood, timber and as a source of income. This practice should be promoted in the area to prevent deforestation and cutting of trees in the forests and at the same time educate people the importance of planting trees for own consumption. The live fences are successful in the area as they provide security in the homesteads which the communities term as a priority. However, there are many other benefits of agroforestry practice which the communities are not aware. The major challenges identified in

carrying out agroforestry practices in the study are inadequate rainfall in the area causing the trees to dry and inadequate knowledge on agroforestry practices and the species of trees to plant in the different practices.

5.5 Recommendations

- i. The government and other stakeholders should promote tree farming in the area so as to prevent deforestation and land degradation in search of firewood and timber from the government forests and land. The government should give incentives to encourage people to plant trees for own consumption and at the same time to restore the degraded environment.
- ii. The most common challenge with all the practices is inadequate rainfall in the area which causes the trees planted to dry. The communities in the area could be trained on the various water harvesting technologies through underground and roof catchments during the heavy rains which can be used to water the trees during the dry areas to avoid the cases of drying up of the young seedlings.
- iii. The community has inadequate knowledge on all the agroforestry practices discussed. Therefore, the government and NGOs working in the area should look into capacity building of the communities on agroforestry practices. This will help to empower the communities in conserving the environment which has been degraded through deforestation and desertification.
- iv. There is also a great need for agroforestry extension services for the farmers in the area so that they can be guided on the agroforestry practices to carry out and the appropriate trees to plant as regards the various agroforestry practices.

5.5.1 Suggestions for further studies

The study suggests that more study on agroforestry be carried out in Maai Mahiu on the right kind of species for different agroforestry practices in the different ecological zones. This should be combined with an extensive study on the level of knowledge by the different farmers regarding the different practices.

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Environmental Issues

Kenya's environment is rich in natural resources, including forests, wildlife, and marine resources. However, these resources are under increasing pressure due to population growth, climate change, and unsustainable development. The government has implemented various policies and programs to address these challenges, including the National Environmental Policy and the Environmental Management and Coordination Act (EMCA).

Kenya's Environmental Policy and the Environmental Management and Coordination Act (EMCA)

The National Environmental Policy (NEP) provides the framework for environmental management in Kenya. It emphasizes the need for sustainable development, which meets the needs of the present without compromising the ability of future generations to meet their own needs.

The Environmental Management and Coordination Act (EMCA) is the primary legislation governing environmental management in Kenya. It establishes the Environmental Management and Coordination Board (EMCB) as the central authority for environmental management.

EMCA provides for the regulation of activities that may have significant adverse effects on the environment. These activities include land use, construction, mining, and the discharge of pollutants.

Environmental Management and Coordination Board (EMCB)

The ECBM is the central authority for environmental management in Kenya. It is responsible for coordinating, monitoring, and controlling environmental management activities.

Key Issues

APPENDICES

APPENDIX I

Transmittal Letter

PAULINE W.KARIUKI

P.O BOX 1508- 90100,

MACHAKOS – KENYA

JUNE / JULY, 2012

ATTN: TO WHOM IT MAY CONCERN

Dear Sir / Madam,

RE: REQUEST FOR PERMISSION TO CARRYOUT RESEARCH

I am Pauline W. Kariuki a master's student at Nairobi University registration number: LS0/64756/2010. I am currently undertaking my research project and the topic is:

'The influence of agroforestry practices on environment, a case of Maai Mahiu, Nakuru County'.

I kindly seek your assistance with the necessary data and information to carry out the assignment. The project research will be purely academic and will not be used for any other purposes.

Your assistance and co-operation will be greatly appreciated.

Thanks in advance, looking forward to working with you.

Yours sincerely,

Pauline W. Kariuki

APPENDIX II

House Hold Questionnaire

The influence of Agroforestry practices on environment in Maai Mahiu Division.

A. Demographic Information

Sample No: _____

Name of interviewer: _____

Location: _____ Village: _____

Name of interviewee: _____

1. Gender [Male] [Female]

2. Age in years: _____

3. What is your level of education completed?

a) Never went to school b) Primary c) Secondary

d) College e) University

4. How long have you stayed in Maai Mahiu? _____

5. What is the total arable land in acres/ hectares? _____

6. What is the type of land ownership?

a) Own / Bought b) Inheritance c) Rent / Hire d) Government land

e) Others (specify) _____

Section B

A. Alley Cropping

1. Are you currently practicing alley cropping? [YES] [NO]

If yes, proceed with the section, if no go to part B.

2. What kinds of trees have you planted with crops in your farm?

3. What role does planting trees and crops have on your farm?

- a) Improve soil fertility through mulch from leaves
- b) Control soil erosion
- c) Source of timber
- d) Source of firewood
- e) Provide shade
- f) Others (specify)

4. What challenges do you face in planting trees with crops?

- a) Lack of knowledge on the appropriate trees to plant with the crops
- b) Inadequate resources
- c) Inadequate extension services on agroforestry
- d) Inadequate rainfall in the areas causing the trees to dry
- e) Infestation of pests and diseases
- f) Competition of trees and crops due to poor tree selection

g) Others (specify)

B. Wind Breakers

5. Do you have trees that you have planted as wind breakers? (Yes) (No)

If yes, proceed with the section, if no go to section C.

6. What kinds of trees have you planted as wind breakers in your farm?

7. What role do the wind breakers play in the farm?

- a) Break the wind
- b) Control soil erosion
- c) Source of timber
- d) Source of firewood
- e) Source of income
- f) Purification of the air
- g) Others (specify)

8. What challenges do you face with the wind breakers?

- a) Lack of knowledge on the appropriate trees to plant
- b) Inadequate resources
- c) Inadequate extension services on agroforestry

- d) Inadequate rainfall in the areas causing the trees to dry
- e) Infestation of pests and diseases
- f) Others (specify)

C. Silvopasture

9. Do you plant fodder crops for your livestock? [YES] [NO]

If yes proceed with the section, if no go to section D.

10. What kinds of fodder crops have you planted?

11. What role do fodder crops have?

- a) Provides feeds for the livestock
- b) Control soil erosion
- c) Provide shade for livestock
- d) Others (specify)

12. What challenges do you face while growing them in your farm?

- a) Lack of knowledge on the appropriate trees to plant
- b) Inadequate resources
- c) Inadequate extension services on agroforestry
- d) Inadequate rainfall in the areas causing the trees to dry
- e) Infestation of pests and diseases

f) Others (specify)

D. Tree Farming

13. Have you planted trees only in your farm? [YES] [NO]

If yes, proceed with the section, if no go to section E.

14. What kinds of trees have you planted in your farm?

15. What is the role of the trees that you have planted?

a) Source of timber

b) Source of firewood

c) Source of income

d) Source of mulch which is used as manure

e) Others (specify) _____

16. What challenges to you face while growing trees in your farm?

a) Lack of knowledge on the appropriate trees to plant

b) Inadequate resources

c) Inadequate extension services on agroforestry

d) Inadequate rainfall in the areas causing the trees to dry

e) Infestation of pests and diseases

f) Poor market prices

g) Others (specify) _____

E. Live Fences

17. Have you planted live fences in your compound? [YES] [NO]

If yes proceed with the section, if no, END.

18. What is the type of live fence that you planted?

18. What role does the live fence play in your compound?

- a) Provides security in the home compound.
 - b) Ornamental
 - c) Source of firewood when pruned
 - d) Others (specify)
-

19. What challenges do you face with the live fence?

- a) Take long to grow to maturity.
- b) Inadequate resources
- c) Inadequate rainfall in the areas causing the trees to dry
- d) Infestation of pests and diseases
- e) Others (specify) _____

-----END-----

THANK YOU FOR YOUR TIME!

APPENDIX III

Observation Schedule

The influence of Agroforestry practices on environment, a case of Maai Mahiu, Nakuru County.

1. Presence alley cropping practices (trees planted together with crops)
2. Presence Silvopasture practices (trees planted as fodder feeds or with animal feeds)
3. Presence wind breakers (trees planted at the edge of the farm to act as wind breakers)
4. Presence tree farming (trees planted on the farm only)
5. Presence of live fences (trees planted as hedges to act as a fence)
6. Improved soil fertility
7. Availability of fire wood from own farm
8. Availability of animal feeds / zero grazing practices
9. Increased agricultural productivity
10. Homestead security
11. Decreased soil / wind erosion

APPENDIX IV

Maai Mahiu Division Map



The map of Maai Mahiu Division (Source: DAO's Office, 2012)