SOCIO-ECONOMIC FACTORS CONTRIBUTING TO THE ADOPTION OF *PELIS* BY FARMERS IN DEGRADED FOREST AREAS OF MARANIA IN MOUNT-KENYA FOREST, MERU COUNTY, KENYA

Jackson Munoru Muthamia

A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Masters of Science in Environment and Natural Resource Management in the Department of Environment and Natural Resources Management and the School of Science and Technology of Africa Nazarene University

August 2020

DECLARATION

I declare that this document and the research that it describes are my original work and that they have not been presented in any other University for academic work.

_____ _____

Muthamia Jackson Munoru Date

16S01DMEV002

This research was conducted under our supervision and is submitted with our approval as University supervisors.

_____ _____

Dr. Mark Ndunda Mutinda Date

_____ _____

Dr. Moses Otiali Esilaba Date

Africa Nazarene University

Nairobi, Kenya

DEDICATION

This research project is dedicated to my lovely family, my wife Rosefaith Muthamia, My daughters Angel Muthamia and Celestial Muthamia for their support through this work. Also to my fellow colleagues for their prayers, sacrifice and support during writing of this project.

ACKNOWLEDGEMENTS

I most sincerely thank the almighty God for giving me good health to carry out this research. I salute my supervisors Dr. Mark Ndunda Mutinda and Dr. Moses Otiali Esilaba who devotedly guided and encouraged me through the project work. I am convinced that without their support, this study would not have been a success.

Mostly especially, I am grateful to my family members who encouraged me to move on amid challenges and tight schedules. I greatly appreciate the encouragement of my classmates throughout the programme who were always available with useful suggestions.

Lastly but not least, I thank all my friends for their social contribution towards my studies. I appreciate the contribution and support towards making this study a success.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

A high growing population has put a lot of pressure on the areas around Mount Kenya forests, where the area has been encroached for agricultural use and timber resources. This has caused deforestation and degradation of soil and water resources. Kibirichia location is one of those areas that have suffered from different forms of land degradation and deforestation. The purpose of this study was to investigate the factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania in Kibirichia location around Mount-Kenya forest in Meru County, Kenya. PELIS System in Kenya was adopted in 1910, and was referred to as *Shamba* system. It was introduced as a modified form of the Taungya system used in south East Asia. The *shamba* system of forest plantation allowed farmers to tend tree saplings on state owned forest land and in return they were permitted to intercrop food crops until canopy closure. The objectives of the study was to investigate on land size, Social demographic factors, payment of forest charges, capacity-building, stakeholder engagement and proximity to the forest on adoption of PELIS by farmers in degraded forest areas. The study was done on *shamba* systems in Kibirichia County assembly ward. County with a population of 24,850 and 2,400 households in Buuri Sub-county. Kibirichia county assembly ward is an electoral ward in Kenya. It is one of the wards in Buuri constituency in Meru County**.** The target population of interest in this study consists of 420 households in Kibirichia county assembly ward in Buuri Sub-county participating in the *shamba* system. This study adopted a descriptive survey design. Stratified random sampling was used to select a sample of 127 households, while purposive sampling was used to select Key Informants for interview. A structured questionnaire was used to collect data from 127 households participating in the *Shamba* systems in Kibirichia county assembly ward. The study used both descriptive and inferential statistics to analyze the data. A multiple linear regression model was used to assess the factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. The results show significant relationships between land size ($\beta=0.890$, $t=23.39$, $p< 0.001$), payment of fees ($\beta=0.118$, $t=2.019$, $p=0.046$), capacity building ($\beta=0.089$, $p=0.012$), and stakeholder engagement ($\beta=0.134$, $t=3.202$, $p=0.002$) and the adoption of PELIS by farmers. Non-significant relationships were found between socio-economic factors ($\beta=0.099$, $t=1.7005$, $p>0.05$), and distance from the forest plots ($\beta=0.048$, $t=1.363$, $p>0.05$) and the adoption of PELIS by farmers. The study recommended the implementation of an elaborate Participatory Land Use Planning (PLUP) process be undertaken by all the stakeholders in order to enhance the sustainability of the PELIS system as it was found to be beneficial to the farmers and the forest conservation initiatives in the area. The following activities and considerations should be taken into account during the planning process: payment of forest plot charges, capacity building, and stakeholder engagement to enhance the adoption of the PELIS in the study area.

DEFINITION OF TERMS

Deforestation: The conversion of forest area to other uses that involves change and destruction of the forest ecosystem including cutting of trees and clearing of other forest cover. Deforestation in Mt. Mount *Kenya* is a threats to the forests by deforestation had consequences on other activities in the mountain area such as wildlife management and even the utilization of forest products such as timber

Ecological restoration: is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER, 2017). In this study forestry development and *ecological restoration* focused on the forested mountains commonly referred as the five water towers of Kenya.

Ecosystem: Ecosystems are those sensitive environments whose degradation or loss results in significant diminution of regional biodiversity. Mount Kenya has several altitudinal ecological zones, between the savannas surrounding the mountain to the nival zone by the glaciers. Each zone has a dominant species of vegetation.

Rehabilitation: Rehabilitation is the act of restoring something to its original state. The rehabilitation of the forest that had once been cleared for use as an amusement park. Rehabilitation, in the study seeks to repair damaged or blocked ecosystem functions, with the primary goal of raising ecosystem productivity for the benefit of local people.

ABBREVIATIONS AND ACRONYMS

CBNRM: Community-Based Natural Resource Management

FDEPS: Fuelwood Development for Energy Project in Sudan

NACOSTI: National Commission for Science, Technology and Innovation

OECD: Organisation for Economic Cooperation and Development

PELIS: Plantation Establishment and Livelihood Improvement scheme

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The study was an assessment of the contribution of the socio-economic factors to the adoption of *PELIS* by farmers in the degraded forest areas of Marania in Mount Kenya forest, Meru County, Kenya. The farmers' socioeconomic factors formed the independent variables for this study, they included: the size of land owned by the farmers, farmers' demographic factors, forest charges (or fees), capacity building, stakeholder engagement, proximity to the forest block. The dependent variable was the adoption of *PELIS* by farmers in the degraded forest areas of Marania in Mount Kenya forest, Meru County. The dependent variable was the level of Best Environmental Management Practices undertaken by the voluntary environmental club members. This chapter introduces the study under the following sub-headings: background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, scope of the study, delimitation of the study, limitations of the study, assumptions of the study, theoretical framework, and conceptual frame work.

1.2 Background of the Study

Agroforestry is an integrated approach to the production of trees and of non-tree crops or animals on the same piece of land (Raintree, 2012). Simple agroforestry systems represent associations of a small number of components, usually no more than five tree species and an annual species (paddy, maize, vegetables, forage herbs) or a tree lot (bananas, cocoa, coffee). The crops can be grown together at the same time, in

rotation, or in separate plots when materials from one are used to benefit another. Agro-forestry systems take advantage of trees for many uses: to hold the soil; to increase fertility through nitrogen fixation, or through bringing minerals from deep in the soil and depositing them by leaf-fall; and to provide shade, construction materials, foods and fuel. (Michon, Mary and Bompard, 2012).

In Canada, agroforestry provides ecosystem goods and services that support integrated management of farmland and rural spaces (Van Rees 2008). Ecosystem services derived from agroforestry practices typically include pollination services from wild pollinators; suppression of crop pests and diseases; nutrient cycling; carbon (C) sequestration; water purification, cycling, and retention; and soil conservation and regulation of soil organic matter. The ecosystem services of trees in tree-based intercropping (also known as alley cropping) have been the focus of several studies in Ontario and Quebec. Beneficial effects identified in these studies include increased soil organic C; greater C sequestration (Oelbermann and Voroney 2011); reduced leaching of water contaminants, including nitrate and Escherichia coli; reduced nitrous oxide (N_2O) emissions; enhancement, diversification, and stabilization of arbuscular mycorrhizal fungi populations; and augmentation of earthworm, bird, and insect populations. Many Canadian citizens are concerned about potential negative ecological impacts of agricultural production, and thus the role of agroforestry in Canada's agricultural landscapes has largely been linked to lessening environmental impacts of modern agriculture while balancing productivity and environmental stewardship. Adaptation and mitigation to climate change impacts are emerging concerns, and key environmental benefits sought to address these concerns include C

sequestration and greenhouse gas (GHG) reductions, soil conservation, nutrient management, and water-quality protection (Van Rees 2008).

In the Congo Basin and surrounding forest landscapes of Central Africa, numerous species are utilized in agroforestry systems (Pye-Smith, 2010). Experience has shown that tree domestication and cultivation is only one component of successful agroforestry; market economics are also crucial. Capacity building programs and microcredit assist landowners to obtain storage facilities in order to be able to provide more constant product supply throughout the year as well as more efficient technology to process fruits and nuts (Sonwa, Nkongmeneck, Weise, Tchatat, Adesina & Janssens, 2007). An important component of agroforestry in the Congo Basin is selecting valuable fruit trees that can produce high yields. Much of this selection is done through a process known as participatory domestication, where researchers work with communities to select varieties and adapt them for local use. Tree cultivation is often done through vegetative reproduction, using techniques such as air layering (marcotting), cuttings, and grafting, which allow greater selection of desirable traits than simple seed planting. Desirable traits for agroforestry species include not just size and taste, but also fast growth and fruiting, and uniform fruit size (Pye-Smith, 2010).

In Kenya, the Forest Sector is key to country's social and economic wellbeing as most of the country's economic sectors rely on environmental based resources for their sustenance (Government of Kenya, 2005). The forest sector contributes about Kenya Shillings 7 billion to the economy and employs over 50,000 people directly and

another 300,000 indirectly. Forest ecosystems also enhance landscape resilience to climate change. In the country's water towers, forests provide environmental services that include water quality and quantity, reduction of soil erosion, and creation of micro-climatic conditions that maintain or improve productivity (Mathu, 2011). Forests are also known to be among the most effective sinks of greenhouse gases, which cause climate change, and hence they are important in contributing to climate change mitigation.

Kenya's land area covers a very wide range of ecological zones. Based on moisture and temperature regimes, the country has been divided into seven main agro-climatic zones, and attempts have been made to further sub-divide these seven zones (Government of Kenya, 2005). Jaetzold and Schmidt (1982) divided the country into agro-ecological zones mainly on the basis of altitude and rainfall. The agro-ecological zones can be said to give an indication of what may be grown in a particular area. Within each zone, local communities may opt for various land-use systems. Their choice will depend on socio-economic factors such as population density, access to markets, level of education, infrastructure and support services, farming practices, the tenure situation, culture and traditions, and also on Government policies. Depending on such factors, therefore, the land-use pattern may evolve differently in different areas even if the ecological conditions are similar. When discussing the Agroforestry potential of various parts of Kenya, both ecological and socio-economic factors need to be taken into account. Hence, it is most appropriate to tie the discussion to actual land-use systems. Such analysis can help us to judge which agroforestry technologies and which tree species are appropriate and the potential that

improved agroforestry practices have for solving the particular land-use problems experienced by farmers in each area.

The Plantation Establishment and Livelihood Improvement Scheme (PELIS) involves farmers planting and tending the saplings on a state owned forests in return for being permitted to intercrop perennial agriculture food crops with the seedlings until canopy closure (about three years). Before being allowed to cultivate in the forest they sign a PELIS cultivation permit where they commit themselves to abide by the rules and regulations that govern the scheme. The scheme is meant to improve the economic gains of participating farmers while ensuring success for planted tree (AFCD, 2012). In mid-2007, acting in conformity with the Forest Act 2005, the Kenya Forest Service (KFS) in collaboration with key sector partners particularly forest adjacent communities revisited the pros and cons of Non–Residential Cultivation (NRC). KFS outlined a new model, rebranded as the Plantation Establishment and Livelihood Improvement (PELIS).

The Kenyan *shamba* system, an arrangement allowing local farmers to grow crops while tending to exotic tree saplings on commercial or state-owned land, has long been supported as a solution to deforestation and an aid to subsistence agriculturalists (Mathu, 2011). Yet closer examination reveals how the Shamba system further endangers indigenous forests in Kenya by alienating local interests from those of the environment, thereby promoting environmental degradation. Although dependence upon native plant species for food and medicine once aligned the interests of indigenous farmers with those of forest ecosystems, imposition of the Shamba system

upset traditional customs of land appropriation, alienating Kenyans from the land on which they relied (Kagombe, 2014).

The system clashes with the practices by which indigenous populations sustain themselves and practices that support forest preservation, as it incentivizes farmers to clear native vegetation and to actively hinder the growth of plantation saplings (Kagombe and Gitonga, 2005). By incentivizing corrupt and unsustainable land management practices, the Kenyan Shamba system assures the continued degradation of montane forest as well as the disruption of normal soil renewal and irrigation processes essential to successful agriculture.

1.3 Statement of the Problem

Mt Kenya Forest Reserve plays a critical role in water catchment functions for the country and is one of the five main "water towers" in Kenya. North East to South West of the mountain is the catchment for Tana River while Western and North Western slopes form the catchment area for Ewaso Nyiro River (Kagombe, 2014). The importance of the Mt Kenya Forest is related to the ecosystem services it provides, such as river flow regulation, flood mitigation, water storage, water purification, recharge of groundwater, reduced soil erosion and siltation, protection of biodiversity, carbon sequestration, carbon reservoir and regulation of microclimate which provides favorable conditions for optimum crop production.

Loss of native vegetation in the mountainous region of central Kenya is considered one of the country's most pressing environmental problems, and it is especially

detrimental to Kenya's agriculture (Maathai, 2010). Kibirichia location suffers from different forms of land degradation and deforestation. It exhibits a high growing population which has put a lot of pressure on agricultural farm resources and water systems from Mount Kenya forests. In functioning montane ecosystems, native forests provide steady water supplies by storing water during rainy seasons and releasing it slowly into rivers during dry periods. This intra-seasonal regularity of river flows bolsters the resilience of agriculturally dependent households against seasonal environmental and economic changes (Maathai, 2010).

The PELIS strategy is an important strategy aimed at realizing this goal. It reduces the competition from weeds, has better growth and a higher survival rate of planted trees. The working relationship between Kenya Forest Service and the cultivators has greatly improved from the previous situation when the problem was the interpretation of the purpose of the cultivation while planting trees (Dewees, 1993; Maathai, 2010). The consequence of this has been low growth and survival rates of planted trees, low forest cover and therefore low per capita water level. The study therefore assessed the factors that contribute to the success of forest plantation establishment and identified measures that can be taken to answer the research questions and ensure the realization of the 10 % forest cover. The past restoration efforts at the Mt Kenya Forest have not been successful evidenced by the massive dying of newly planted trees leading to duplication of reforestation efforts. There is no research study that documents the factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania (kibirichia) in mount-Kenya forest, Meru County, Kenya

1.4 Purpose of the Study

The purpose of the study was to investigate socio-economic factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

1.5 Objectives of the Study

The following were the research objectives;

(i) To examine the contribution of the size of land owned by the farmers on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

(ii) To assess the contribution of the farmers' demographic factors on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

(iii) To determine the contribution of payment of forest plot charges on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

(iv) To assess the contribution of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

(v) To establish the contribution of the stakeholder engagement on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

(vi) To examine the contribution of the proximity of the forest from farmers' homes on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

1.6 Research Questions

The study sought to answer the following research questions:

(i) How does the size of land owned by the farmers contribute to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(ii) What is the contribution of farmers' demographic factors on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(iii) What is the contribution of payment of forest plot charges on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(iv) What is the contribution of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(v) What is the contribution of the stakeholder engagement on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(vi) What is the contribution of the proximity of the forest from farmer's homes on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

1.7 Significance of the Study

The study is significant to the national and county government of Kenya, the vision 2030 secretariat, public and the communities of the surrounding areas of the Marania *Shamba* Systems in Mount Kenya forest, as it will provide information relevant for measuring the success of rehabilitation sites and what needs to be done so that rehabilitated sites and the ecosystem remain healthy and can play it role is sustaining livelihood and support key economic development activities downstream through agroforestry programs. These will also help the government realize the need for rehabilitating the site and provide funding and resources for future agroforestry programs on rehabilitation and restoration forests in other key forest ecosystems in Kenya. The importance of rehabilitation and restoration forests activities will also not been gradually understood; and this study will help in understanding the need for evaluation and best criteria to be used.

The need for agroforestry programs on rehabilitation and restoration forests has been understood however commitment of resources for rehabilitation remains a challenge. Institutional commitment even in the case of availability of resources remains weak even on Marania Shamba Systems. Scientists and policy makers will recognize the effect of agroforestry programs on rehabilitation and restoration forests. Redesigning and improvement of the current programs can also be effected. Current investment in careful planning and design of evaluating programs will result in high-quality data for years to come and improvement of approaches for rehabilitation of similar ecosystems, as well as the criteria used for that purpose.

1.8 Scope of the Study

The study was confined to the Marania Shamba Systems in Kibirichia Sub-County in Mount Kenya forest Kenya which has and is currently undergoing rehabilitation and restoration forests through agroforestry and therefore provided a good site to assess as information that was obtained would be rich source of data.

The variables that were measured and determined were: land size, Social economic factors, payment of fees, capacity-building, stakeholder engagement and distance to the forest and adoption of PELIS by farmers in degraded forest.

1.9 Delimitation of the Study

The study was limited to the Marania forest block on Mount Kenya. The other forest blocks on Mount Kenya were not covered due to limitations of time and cost and the vastness of the forest blocks on Mount Kenya.

1.10 Limitations of the Study

The study was limited to the Marania Shamba Systems in Mount Kenya forest, Meru County Kenya and therefore information derived could not be generalized to the other forest ecosystems in the country. The factors that were examined in this study were only on stakeholder engagement, Capacity-building, Seedling production, Sustainable agricultural systems and rehabilitation and restoration of forests. It is known that Kenya like many African countries is heavily reliant on its Natural resources and since it has a wide range of forests there is therefore need to examine the agroforestry factors that effect on of rehabilitation and restoration forests in general.

The study focused on team managers at Mount Kenya forest Coordinating Secretariat, the Ministry of Environment, Water and Natural Resources and the local communities on Marania Shamba Systems live within and around the Mount Kenya forest.

1.11Assumptions of the Study

The study was carried out on the basis of the following assumptions: (i) the sample chosen for this study was representative of the population, (ii) the respondents answered the questions correctly and truthfully, that all the respondents would give genuine, truthful, and honest responses to the questionnaires.

1.12 Theoretical Framework

This study was guided by the two theories, which included: Natural resource management theory and ecosystem function theory.

1.12.1 Natural Resource Management Theory

Natural resource management theory and practice has shifted significantly in recent decades. In many countries environmental management has been the realm of national or state governments, with little recognition of the people living closest to the resource. However, the idea that local people may have a role to play in the planning and management of their surrounding environments is gaining ground. One form in which this concept has been applied is community-based natural resource management (CBNRM). By decentralizing natural resource management, CBNRM is an effort to incorporate local communities into guardianship of their immediate environment in an attempt to meet ecological and social goals on both local and global scales (Agrawal & Gibson, 2009).

The practice of CBNRM has been supported by a number of movements and paradigm shifts in theory regarding humans and the environment. The “flux of nature” paradigm shift in ecology, for example, promoted new thinking in how species, especially humans, relate to their environments. The flux of nature concept has various elements, namely that a systems approach is most appropriate for ecosystem management, humans are a part of the landscape, and participation by humans in natural resource management is a viable and necessary endeavor (Berkes & Seixas, 2017). This conceptual change allows for more incorporation of local groups in management of natural resources rather than trying to exclude them completely as has been done historically (Agrawal & Gibson, 2009; Berkes, 2017).

Applications of CBNRM are as diverse as the reasons for its inception. This is due to differing goals, resources, and socioeconomic, political or environmental circumstances that form the context in which a project is situated (Berkes & Seixas, 2017; and Kellert, et al. 2010). CBNRM has been implemented in the form of community wildlife management, community forest management, community watershed management, extractive reserves, integrated poverty alleviation and conservation initiatives, ecotourism, and others (Agrawal & Redford, 2006).. Forests provide numerous ecosystem services, products for human consumption, and habitat for myriad species. This is complicated by unclear land tenure because native groups often have no documentation of ownership (FAO, 2007). CBNRM in developing countries has been initiated by international non-governmental organizations, international institutions (e.g. United Nations), and national governments.

1.12.2 Biodiversity-Ecosystem Function Theory

Biodiversity-ecosystem function theory can help planners identify models that might serve multiple stakeholders. This theory predicts that ecosystem processes, such as productivity, increase with species richness (Hooper et al., 2005), although there is considerable debate about the extent to which effects are due to species richness (the number of species) vs. the inclusion of one or more productive species in the assemblage (Loreau et al., 2002). If diversity and function are correlated, then a project that simultaneously provides high biodiversity and multiple ecosystem services could attract broad support. Those interested in plants and birds, for example, would champion a project aimed at maximizing species richness, while those interested in recreational fishing and drinking water supplies would welcome a project that produced cleaner water.

Restoration expectations are moving from the idea that a specific outcome can be achieved to the reality that some outcomes will not be feasible within the scope of a given project (Ehrenfeld, 2014). Models are now based on the new paradigm that ecosystems are potentially open systems, regulated by external processes, have multiple endpoints, follow multiple pathways (trajectories) and undergo both natural disturbances and human effects. Ecosystems are dynamic and nondeterministic (Hobbs & Harris, 2015). Projects can thus be evaluated in relation to a range of potential outcomes. The larger the project, the more flexible the goal will need to be. Biodiversity-ecosystem function theory likely to help conservation managers in practical decisions, except in the particular case of restoration. We gave recommendations for increasing the relevance of this area of research for conservation

1.13 Conceptual Framework

The Independent variables in this research were land size of land owned, social economic factors, payment of fees, capacity-building, stakeholder engagement**,** distance between farmer's homes and the forest. The dependent variable was rehabilitation and restoration of forests. The moderating variable is the Government polies on PELIS.

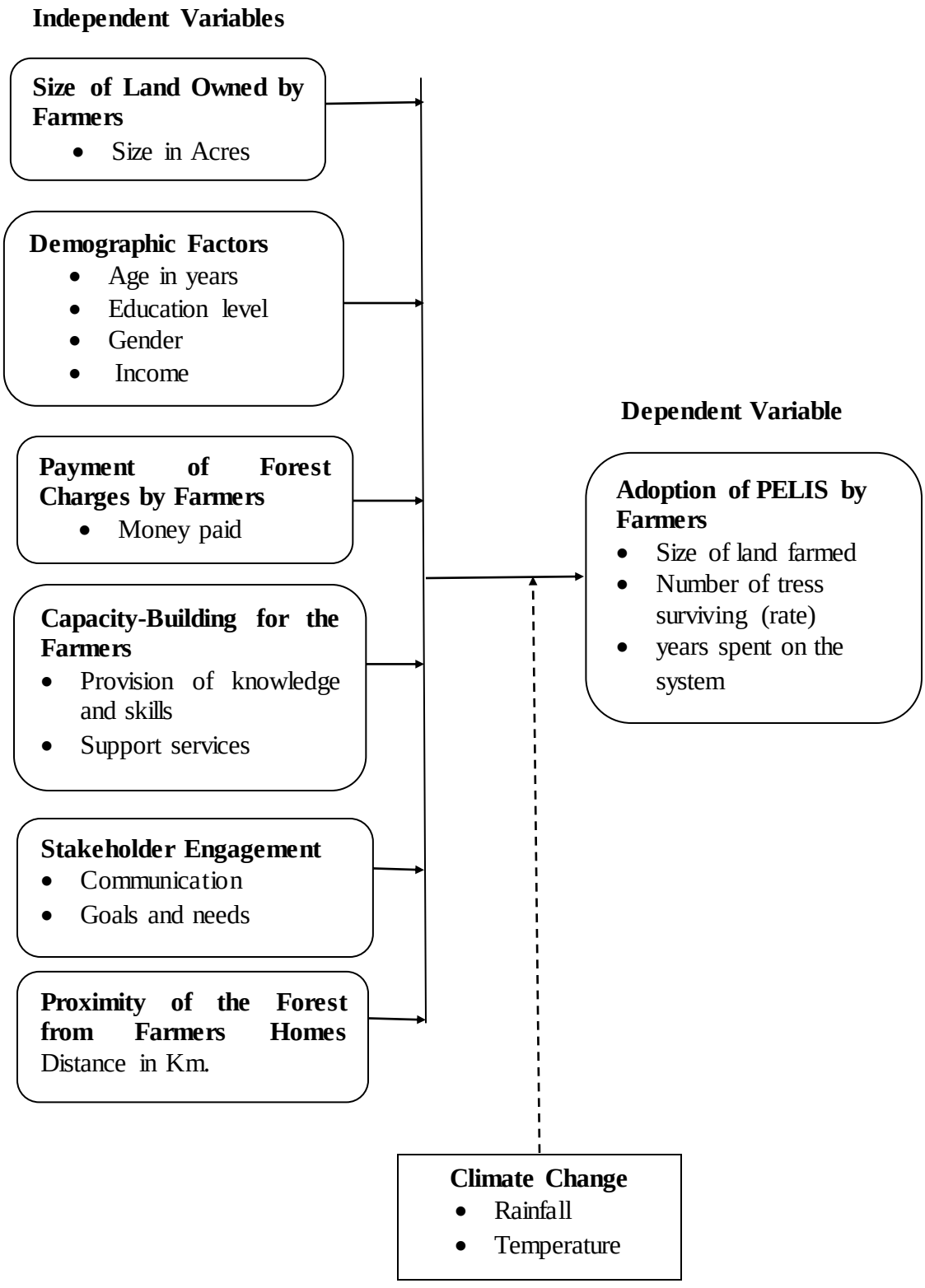


Figure 1: Conceptual framework showing the contribution of independent factors on the adoption of PELIS by farmers in Marania Mount Kenya Forest, Meru County

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covered literature as per the study objectives on to investigate on factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. The study examined the effects of land size, Social economic factors, payment of fees, capacity-building, stakeholder engagement and distance to the forest on adoption of PELIS.

2.2 PELIS System in Kenya

In Kenya, PELIS System in Kenya was adopted in 1910 and was referred to as *Shamba* System. First introduced as a modified form of the Taungya used in south East Asia; the *shamba* system was a method, of forest plantation established in which farmers tend tree saplings on state owned forest land in return for being permitted to intercrop food crops until canopy closure. The *shamba* system significantly reduced the cost of forest establishment as weeding costs were borne by the farmers. The system also provided significant benefits to farmers in the form of food.

In 1990s the shamba system was often abused and young trees were often neglected or deliberately cut to enable cultivation to continue beyond the usual three years period. These actions slowed down reforestation progress and resulted in vast areas of land under cultivation within forest reserves. Following these mishaps the system was banned by presidential decree in 1987, and in the following year all forest residents were evicted from forest areas. The shamba system was subsequently replaced by a

modified system referred to as Non- Residential Cultivation (NRC). In the NRC, farmers were integrated into the Forest Department (FD) as resident workers. Under NRC the farmers were allocated plots, still by the name, shambas' but with guaranteed work for nine months per year. The produce from the shambas was considered part of workers emolument as they tended the young trees. This NRC too was banned after a few years and was being replaced with a redesigned system referred to as the Plantations Establishment and Livelihood Improvement Scheme (PELIS). The scheme was reported to have increased acreage to cover over 8,000 hectares following its implementation (Ndomba *et al.;* 2014).

2.2.1 Implementation of the PELIS Policy Guidelines

According to a paper by Oduol, (2012) of the International Council for Research in Agroforestry (ICRAF) on the management of the shamba system; the origin of the shamba system could be traced back to the 1850's in Burma where it was used as a means of replanting teak plantations of badly degraded land. It was essentially a modification of the traditional shifting cultivation, but various forms of the practice are found in different parts of the tropics. The shamba system is a form of Taungya (shifting cultivation) where agricultural food crops are grown alongside the forest tree species. The origin of shamba system (Taungya) could be traced back to the 1850's in South East Asia (Burma) where it was used as a means of replanting teak plantations of badly degraded land. The successful implementation of the Taungya system in Burma saw Myanmar continue to supply substantial stocks of timber (especially teak) to India and Indonesia.

According to Myanmar's statistical year book (2007) a total 525,785 acres of plantation had been established between 2004 and 2007.In the 1930's Ghana launched Taungya system (shifting cultivation) of plantation development adopted from Myanmar (FAO 2015) where farmers were given parcels of degraded forest reserves to produce food crops and to help establish and maintain trees. The purpose was to produce commercial timber in a short time as well as address the shortage of farmland in communities bordering the forest. A total of 75% of Ghana's commercial public and private forest plantations (35,000 hectares) were established under this system. Farmers however, had no rights to benefit sharing or decision making and the result was neglect and abuse of the system i.e. refusing to weed, over pruning and debarking (Mitton & Birikorang 2015).

The shamba system practices continued to change over time. From 1910 to 1975, the forest cultivators were integrated into the Forest Department (FD) as resident workers in plantation establishment (Kagombe & Gitonga 2005). They were allocated forest plots (*shambas*) and guaranteed work for nine months per year. The produce from the plots was considered as part of the workers' pay as they tended the young trees. The system changed in 1975 and the resident workers were permanently employed by the FD and required to rent the plots. The offer of tenancy was extended to others outside the forest and the number of cultivators rose significantly and supervision became a problem. The involvement of third parties resulted to abuse of the whole system. The resident workers (cultivators) assumed squatter rights and started encroaching on prohibited areas.

2.3 Land Size and Adoption of PELIS

A case study done in Njoro area East of Mau forest indicated that farming community in this area utilize the plantation area to grow food crops especially vegetables during the dry season (Albertazzi, Bini, Trivellini 2018). Shamba system gives high returns to farmers by close to K.Shs 120,000 per hectare per year it creates employment to farmers and ensures food security. (Kagombe, 2009). Forest management is important for people who gain a livelihood from the forest because people can only have a stable source of livelihood if forests are sustainably managed. In that way people can overcome their vulnerability based on forests (Hoogenbosch, 2010).

Land size is a very critical agricultural production resource that influences technology adoption by farmers; land size determines the extent to which the farmers will use their land for the adoption. Small scale farmers with smaller land pieces, lack of land bigger enough to be provided as security in order to secure credit facilities from financial institutions will be a limiting factor to the uptake and adoption of new innovations available. Land size is also a critical agricultural production factor for modern technology agricultural adoption for instance, in Bihar India, Singh et al (2014) and Mohammad (2011) found out that small sized land holdings and too much fragmented land were the main limiting factor to the adoption of modern horticultural technologies. Farmers with smaller land holdings will not take any risk to adopt any new technology available. A critical examination of the economic factors influencing the use of modern agricultural practice introduced in any farming system the results obtained shows that smaller land sizes hinder the smallholder farmers‟ economic viability and thus the adoption of modern agricultural technologies in Western Kenya.

The rate of agricultural technologies adoption is influenced by a range of factors which have been broadly categorized into; economic, social and institutional factors (Mamudu et al, 2012). The economic factors which have been identified include land size, initial cost of a technology or its expected benefits after adoption verses the cost incurred during adoption and the farmers‟ income levels from other off-farm economic activities.

2.4 Social Economic Factors and Adoption of PELIS

Although PELIS was established mainly to promote forest plantation development through enhancing forest establishment and the survival of plantation trees, it has also provided other significant benefits such as making available arable land for the landless and contributing to food production. Plantation establishment and livelihood improvement scheme (PELIS) a modified form of non-residential cultivation that was practiced in earlier years in Kenya as a method of plantation establishment (GOK, 2005; GOK, 2006; FAO, 2006). PELIS was initiated with the objectives of fully rehabilitating and protecting the forest and improving the livelihood of the forest adjacent communities (GOK, 2005).

Social factors that have identified to influence the chances of adoption by a farmer include; the farmer's age, level of education, gender and his social groupings. Institutional factors that influence and determine the rate of agricultural technologies adoption and uptake by farmers include; access to information about the technologies through the existing and accessible information sources, nature of policies and provisions enacted by the government and access and nature of the extension services

provided. As Langat et al (2013) also noted adoption of modern agricultural technologies by small scale farmers is both externally and internally challenged and hindered by a wider range of factors which have led to most farmers adopting modern technologies at alarmingly slower rates. Physical environmental factors are those external factors that determine how the farmers will adopt the existing modern technologies and they include factors such as; natural calamities for example prolonged droughts and floods some of the physical factors are well beyond the control of the local subsistence farmer, other external factors include; poor quality and sub-standard farming technologies being disseminated to farmers and non-supportive government policies that have been put in place by the existing government departments. Internal factors include; pests and disease, soil infertility, land availability and faster population increase.

Enabor (1979) observed that, introduction of Taungya system into the humid tropics was a response to various socio-economic factors. For example in Nigeria, a major objective was to solve the problem of high cost of forest regeneration. One benefit of shamba system is low cost of plantation establishment. Taking wage of K.Shs 80.00 and current task rates, costs of establishment of plantation per hectare compounded at 15% to the end of 30 years rotation, was found to be approximately K.Shs 277, 000 for NRC areas. This means that NRC is critical to economic development of plantations (World Bank, 2017). In 1990's FD reduced its staff through the retrenchment programme, which had an aim of reducing government expenditure. This means only a skeleton staff remained in the forests stations (Kagombe, 1998).

The project (GZDSP) has improved the livelihood of the communities living adjacent to forests through support of income generating activities (IGAs) which they depend on for survival. The model they engage in while rehabilitating degraded sites is Plantation Establishment and Livelihood Improvement Scheme (PELIS) which provided for communities to cultivate the forest area and plant crops for up to three years as they tend for the seedlings in the rehabilitated area. Mr. Kemau of the many beneficiaries said that the project activities enabled him buy a motorbike and purchase a ten acre piece of land in Gathiuru which he has started to construct. The communities utilize grazing rights, PELIS and fuel wood collection among other forest activities (KFS, 2014)

2.5 Payment of Fees and Adoption of PELIS

One of the key objectives of PELIS was to reduce the cost of plantation establishment that currently stood at K.Shs 54,500 per hectare at three years using the pitting and spot weeding method as compared to about K.Shs 30,350 per hectare under 'shamba' system (KFS, 2007). KFS will benefit from this scheme by saving money that would otherwise be used for land preparation and subsequent maintenance of the planted areas which will be utilized in other conservation programmes. (Chamashama, *et al.* 1992) observed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial income to the peasant farmers and reduction of forest plantation establishment costs.

The study by Monela *et al.*, (1991) on analyzing the Taungya system at the North Kilimanjaro Forest plantation in Tanzania, limited to an examination of costs and

revenues resulting from the practice and also the impact the system has on tree survival and food crops yields. The results showed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial, income to the peasant farmers and reduction of forest plantation establishment costs. Therefore the system is suitable and should be sustained.

To ensure enhancement of accountability and transparency when formulating regulations and guidelines for cost –benefit sharing mechanisms. This study revealed that some of the key parameters that influence inputs and outputs in PELIS include participation in silvicultural operations, which in the views of communities are technical and tedious. These activities include staking, pitting, seedlings production, planting, pruning and thinning (KFS, 2014). The communities argue that they should only be engaged in land preparation and weeding, which has direct effect on agricultural production. In determining community inputs, the individual input into each specific task should be taken into account. Farmers are allowed to do weeding of the trees and to do pruning and pollarding as practices that will hasten tree growth. However, these practices are practiced upon issuance of a permit by the Kenya Forest Service (KFS). The weeding of trees and care of the seedlings ensure high survival rate and hence assured of maturity. This also helps reduce cost on the side of KFS that would have employed casuals to do the weeding.

2.6 Capacity-building and Adoption of PELIS

Agroforestry needs to mobilize human and institutional capacity for research to generate knowledge; for education to advance the communication of the knowledge; and for extension and development agencies to bring the knowledge to practical use and application. The nature of capacity mobilization activities may range from supporting educators to teach agroforestry and supervise graduate research students and other young scholars through mentoring and on-the-job training, seminars, workshops and conferences. The capacity of NARS, NGOs and policy-makers may be mobilized through a variety of tailored and contextually appropriate capacity development activities (Pearson, 2011). Ongoing capacity development through professional education and training, extension support services and the strengthening of national research capabilities is essential for improving planning, management and technical decision-making on forest restoration and rehabilitation and to enable organizations to understand and respond to the priority needs and aspirations of stakeholders. In particular, nursery managers and staff should be trained and supported to produce high-quality seedlings with the best possible chance of establishing in the field and growing rapidly when planted out in the often difficult environment of a deforested or degraded site (Christensen & Lundvall 2017).

Capacity development is much broader than mere knowledge and skill development through training and education. As an important element of the new consensus between donors and developing countries in the context of the 2005 Paris Declaration on Aid Effectiveness, capacity development is now considered the responsibility of partner countries with donors and outsiders playing a support role of mobilizing

capacities that reside within individuals and institutions (OECD, 2014). Partner countries commit themselves to "integrate specific capacity strengthening objectives in national development strategies and pursue their implementation through country-led capacity development strategies where needed," while donors and others commit themselves to "align their analytic and financial support with partners' capacity development objectives and strategies, make effective use of existing capacities and harmonize support for capacity development accordingly"

Strengthening people's capacity to determine their own values and priorities, and to organize them to act on these, is the basis of development (Eade & Williams, 2018). Ann (2017) defines capacity building as a process of developing and strengthening the skills, instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive in the fast-changing world. UNDP (2010) defined capacity building as the creation of an enabling environment with appropriate policy and legal frameworks, institutional development, including community participation, human resources development and strengthening of managerial systems, adding that, UNDP recognizes that capacity building is a long-term, continuing process, in which all stakeholders participate (ministries, local authorities, non-governmental organizations and water user groups, professional associations, academics and others.

Agroforestry is now seen as a science that is of increasing interest to a wide variety of disciplines. Perspectives are changing and many new agroforestry programmes are being developed within agriculture, forestry, environmental education and other land-use programmes. Agroforestry is currently considered as an important entry point for

holistic natural resources management studies within educational institutions. Temu and Garrity (2003) observe that agroforestry also provides an entry point for biodiversity education. Despite viewing agroforestry as a broad-based discipline touching on various sectors, most national agricultural institutes and university faculties still remain very sector-based with separate institutions for agriculture, forestry, wildlife, livestock, etc. Integrating the agroforestry agenda therefore represents a significant challenge, especially in cases where there is no institutional collaboration between sector-based institutions, ministries or faculties.

2.7 Stakeholder Engagement and Adoption of PELIS

Forest restoration and rehabilitation efforts will only be sustainable if they are socially acceptable. The principal stakeholders (e.g. forest owners, local communities, concessionaires, and forest and other authorities in charge of land use) should be engaged from the start to the end, such as, agreeing on long-term goals, on roles and responsibilities and the equitable distribution of incentives, costs and benefits; establish a consensus on the trade-offs involved in addressing the drivers of forest degradation; and discuss a preliminary forest restoration or rehabilitation plan. Forest restoration planning, evaluation, management and implementation are major and urgent challenges for forest health and sustainable development in the United States and many other regions of the world (Dudley, 2006). Forest managers, stakeholders and private landowners need to use all possible means to assist in this important undertaking. A major challenge for forest rehabilitation is that its effects are difficult to measure at the time of implementation. Thus, rehabilitation represents a long-term investment with potentially high risk and uncertainty. Intensive evaluation requires

more in-depth quantitative monitoring and analysis over a longer time frame at a higher cost. Such an evaluation provides a quantitative assessment of pre- and post-treatment site condition and ecosystem recovery based on measurement of several key response indicators (Block, Franklin, Ward, Ganey & White, 2015).

At the landscape level, forest restoration and rehabilitation projects interact ecologically and socioeconomically with all other land uses, such as agriculture, urban living, water production, infrastructure and industry. Accordingly, they should be based on a coordinated, transparent and Participatory Land-use Planning process with full stakeholder engagement linking agriculture, forestry and other land uses in the landscape (Dewees, Place, Scherr, & Buss, 2011). Ensuring transparent, just and sound stakeholder engagement is at the heart of all successful forest restoration and rehabilitation projects. Such engagement includes a comprehensive analysis of interactions among local communities, agriculture, animal husbandry and natural and planted forests, an adequate diagnosis and evaluation of the drivers of forest degradation, and an honest assessment and discussion of the benefits of forest restoration or rehabilitation for local communities and society at large (Evans, 2009).

Stakeholder engagement should also take into account gender issues. Both men and women are important players in the process of forest restoration and rehabilitation and should be consulted, in particular for the analysis of the causes of forest deterioration and at each stage of the resource planning process (FAO, 2011). Case studies in many African countries give evidence that women can play a significant role in forest restoration and rehabilitation. In Niger, e.g., the inclusion of women in decision

making was fundamental in addressing land conflicts and managing the regeneration process of degraded forests. Women in Senegal and Ghana, were more likely (than found in other studies) to embrace complementary support programs, such as the usage of group savings and the use of wild fruits and berries for nutritional and medicinal purposes. Hence, if women participate and exercise control over resource use, communities benefit, especially with regards to child nutrition and family health.

2.8 Distance to the Forest and Adoption of PELIS

Access and provision of extension services in Kenya is hampered by the long distances to the extension offices from the various farming points farmers have to travel long distances to access extension services since over the recent years the government policy on extension services provision in Kenya has changed from extension- driven to demand- driven approach (Kinyanjui, 2012). The government policy on extension is that the farmers are only provided with extension services if they ask for them.

The government's efforts in improving the welfare of communities around the forest of which is done by allowing the public to participate in work / processing forestry land, by planting crops together with forest trees (agroforestry). Agroforestry has an important economic function for society as a source of income. Based on the calculation by Foresta and Michon (2014) various agroforestry in Indonesia are capable of supplying 50% - 80% of the agricultural rural income through direct production and other activities related to the collection, processing, and marketing results. As a producer of cash, agroforestry can be regarded as a "bank" true, which

can cover the daily needs of family farmers. In addition, the diversification of existing plants, agroforestry is able to ensure the security and peace so that farmers for the farmers to make a profit. However, the activities during the process over land use often affects the soil surface. Felling of trees and land treatment resulting in the surface of the soil to be open, so that if it rained blows rainwater directly. Various kinds of direct interference can also damage the surface of the soil, as a result of the traffic of vehicles, animals and humans in a variety of activities such as cutting and transporting trees, preparing the land and planting trees (Bensel, 2018). This occurs when the cultivation of crops not think of environmental rules, think how to get the maximum economic benefit.

The farmers live from the county extension offices where the extension officers are based, the lower the frequency of visits by extension officers and small scale farmers to provide or seek for training because the extensive distances that have to covered to demand or provide extension services limits the number of visits. As the study found out the delivery of extension services is also negatively affected by low budgetary allocation to the government departments involved in extension, few extension officers covering bigger regions and lack adequate facilitation for the extension officers with reliable means of transport. This therefore means that the officers are unable to make frequent visits to the farmers for follow ups also the current Government policy of farmer demand driven extension which the study found out is mostly being applied by all the extension officers who responded require the farmers to visit the extension offices to seek for the extension services on contrary with the doctor- patient model.

2.9 Summary and Research Gap

The most recent important development in agroforestry was the formulation of new research priorities that address more widely the integration of forestry and agricultural problems: mitigating deforestation, alleviating poverty, devising sound alternatives to slash and burn agriculture, helping biodiversity conservation through improved agroforestry practices or carbon sequestration through tree growing. In this new strategic context, agroforestry would benefit substantially by including a broader vision of its "forestry" mandate. Sustainable agriculture and sustainable forestry need to be achieved if we are going to leave land on which future generations will be able to meet their needs. The agroforestry paradigm can help in revising the relations between central State power and farmers' communities in forest areas. Smallholders or landless farmers all over the tropics have often been largely deprived of their traditional forest resources by forest development projects and expelled from forest lands by coercive forestry regulations.

Many researchers indicate the poorer people to be more dependent on natural resources. Therefore household socio-economic characteristics may play a role in resource use decision making. Understanding factors influencing community participation in forest management programs such as PFM may be critical to forest managers and decision makers. Factors motivating their participation in decisions and activities for preservation of state forests or protected areas may be likewise important. A better understanding of community members' motivation for participation in PFM is fundamental to the development and implementation of

management strategies that are both sustainable in the long term and sensitive to the local need.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The section described the research design that was used in the study, study population, sample population and sampling procedure, data collection methods, and data processing and data analysis. The chapter ends with a discussion of the ethical considerations that guided the study.

3.2 Research Design

This study adopted a descriptive research design and used both quantitative techniques of research to gather in-depth information. This design was preferred because very large samples are feasible, thus making the results statistically significant when analysing multiple variables. Data from the household in Kibirichia county assembly ward in Buuri Sub-county were obtained using a research questionnaire while data from key informants was obtained using an interview guide.

3.3 Research Site

The study was done on shamba systems in Kibirichia county assembly ward. Kibirichia County Assembly Ward Population is estimated at 24,850, with approximately 2,400 households in Buuri Sub-county. Kibirichia county assembly ward is an electoral ward in Kenya. It is one of the wards in Buuri constituency in Meru County**.** Kibirichia Location (Kibirichia Location) is an administrative division (class A - Administrative Region) in Eastern, Kenya (Africa) with the region font code of Africa/Middle East. It is located at an elevation of 2,160 meters above sea level.

Its coordinates are 0°7'60" N and 37°30'0" E in DMS (Degrees Minutes Seconds) or 0.133333 and 37.5 (in decimal degrees). Its UTM position is CA31 and its Joint Operation Graphics reference is NA37-14.

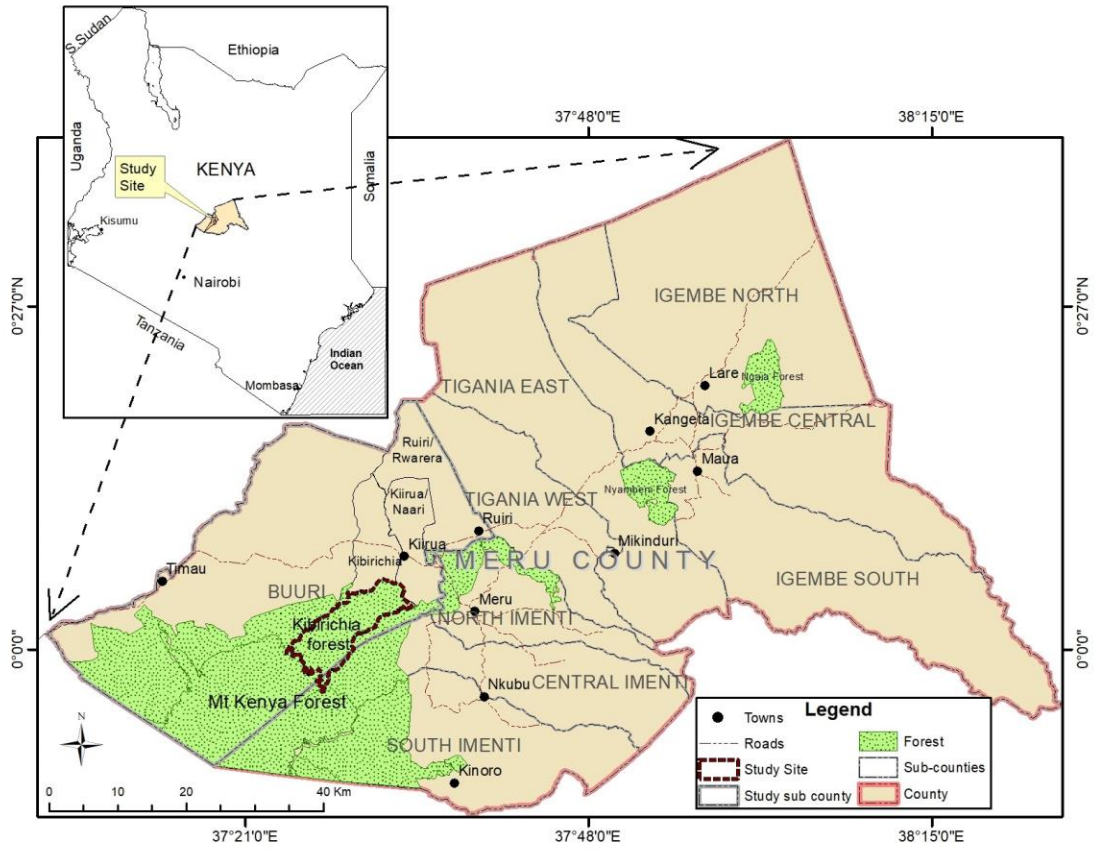


Figure 3.1 Location of Marania Forest Block on Mount Kenya

3.4 Target Population

Target population is the specific population about which information is desired. The target population in this study consisted of 420 households which are engaged in the *shamba* systems in Kibirichia county assembly ward in Buuri Sub-county.

Key Informants included: 3 Chiefs, 1 county administration officer, 2 Members of County government and donors of *shamba* systems officials to be interviewed.

3.5 Study Sample

3.5.1 Study Sample Size

The sample size was obtained by calculating the sample from the target population by applying Cooper and Schindler, (2003) formula:

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

Where: n= Sample size, N= Population size e= Level of Precision.

At 95% level of confidence and P=5

n= $420/1+420(0.05)^2$

n= 204

3.5.2 Sampling Procedure

The study employed stratified random sampling technique to obtain the households. The area was stratified into three stratum, the lower, middle and higher areas. In each of the three strata the household heads were selected at random. The sampling frame of 420 households was used to select at random the respondents. Purposive sampling was used to select the key informants for this study.

Sampling technique can be defined as the methods of coming up with a representative sample of the total population as possible (Kothari 2004). Simple random sampling is a sampling technique where every item in the population has an even chance and likelihood of being selected in the sample. Here the selection of completely depends on chance or by probability and therefore this sampling items technique is also sometimes known as a method of chances. Purposive sampling was done to select the Key Informants for the Key Informants Interview (KII) who included: 3 Chiefs, 1 county administration officer, 2 Members of County government and donors of *Shamba* systems officials who had vital knowledge about the role of agroforestry programs on rehabilitation and restoration of forests.

3.6 Data Collection

The researcher used a structured questionnire and a Key Informant Interview schedule to collect data.

3.6.1 Data Collection Instruments

A researcher administered questionnaire and a Key Informants guide were used to collect data from 204 households participating in the PELIS systems in Kibirichia county assembly ward. This offered the researcher the opportunity to ask the respondent questions in a language that they understood well. The structured questionnaire used (Appendix B) was divided into seven parts, where part 1 had questions on the demographic information of the farmer, part 2 had questions on the adoption of PELIS by farmers, part 3 socio-demographic factors affecting farmers adoption of PELIS, part 4 forest charges on plots, part 5 capacity building, part 6 stakeholder engagement, and part 7 proximity to the forest. The questionnaire

contained both open and close-ended questions. Open ended and close ended questions were developed and administered to the elderly people to fill in or the researcher to tick the answers. The open-ended questions allowed the respondents to communicate their views freely without being forced to fit within the answers. The close-ended questions were presented to the respondent a set of answers that closely represent their views to choose from.

Interviews were conducted with the key informants. The key informants for these interviews included 3 Chiefs, 1 county administration officer, 2 Members of County government and donors of shamba systems. These interviews were useful in providing an in-depth understanding the role of agroforestry programs on rehabilitation and restoration of forests.

3.6.2 Pilot Testing of Research Instruments

The instruments were pilot tested on 24 farmers in the forest Block adjacent to Marania. The results of the pilot testing were used to correct the study questionnaire and to calculate the Cronbach's alpha a measure of internal consistency of the questionnaire. The ambiguous and not easily understood or questions that were ambiguous or poorly constructed were modified to suit the objectives of the study.

3.6.3 Instrument Reliability

The 24 questionnaires were pre-tested through a pilot test with individuals from a different county. To test validity of the designed and developed instruments, the instruments were availed to the supervisors who then guided the researcher and

advised accordingly on the ways of improving the research instruments before the researcher commenced on data collection.

Reliability was tested using Cronbach's alpha. An alpha score of 0.70 or more indicated the instrument was reliable. Besides this, pre-testing aided the researcher in clearing any ambiguities and ensuring that the questions posed measure what it was intended.

3.6.4 Instrument Validity

In most cases in data collection, errors usually arise from such factors as, inaccurate data coding, ambiguous instructions to the respondents, interviewers and interviewees fatigue and bias. To address that problem, the questionnaire used simple words and short sentences which were easy to understand and comprehend

3.6.5 Data Collection Procedures

Data collection procedure refers to the means by which the researcher uses to gather the required data and information. The study used primary data which was collected using well-structured questionnaire. Prior to data collection exercise, the enumerators were trained on the procedures, which happened during the pilot exercise. Care and control was taken by the researcher to ensure that all the questionnaires issued to the respondents were received. To achieve this, the researcher maintained a register of questionnaires which were given to the enumerators and received back.

3.7 Data Processing and Analysis

According to Cooper & Schindler (2003), the process of data analysis involves several stages: the completed questionnaires were edited for completeness and consistency, checked for errors and omissions and then coded to Statistical Package for the Social Sciences (IBM SPSS Version 26). The study used both descriptive and inferential statistics to analyze data from the questionnaires. Descriptive analysis included statistics such as mean scores and standard deviations, frequency distributions and percentages. The inferential statistics included multiple linear regressions were used to establish the nature and magnitude of the relationship between variables and to test hypothesized relationships. A multiple linear regression model was used on the factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya as shown below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$$

Where;

Y = Adoption of PELIS (Dependent Variable)

β_0 = Constant Term

$\beta_1, \beta_2, \beta_3, \beta_4 \beta_5, \beta_6$ = Beta coefficients

X_1 = Land size

X_2 = Social economic factors

X_3 = Payment of fees

X_4 = Capacity-building

X_5 = Stakeholder engagement

X_6 = Distance to the forest

e = Error Term

Table 3.1: Summary of Data Analysis

Study Objective		Variables	Statistical analysis
(i)	To examine the contribution of land size on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya	Land size	Descriptive statistics, Regression analysis
(ii)	To assess the contribution of Social economic factors on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya	Social economic factors	Descriptive statistics, Regression analysis
(iii)	To determine the contribution of payment of fees on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya	Payment of fees	Descriptive statistics, Regression analysis
(iv)	To assess the contribution of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya	Capacity-building	Descriptive statistics, Regression analysis
(v)	To establish the contribution of stakeholder engagement on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya	Stakeholder engagement	Descriptive statistics, Regression analysis
(vi)	To examine the contribution of distance to the forest on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya	Distance to the forest	Descriptive statistics, Regression analysis

3.8 Legal and Ethical Consideration

The researcher sought approvals from the National Commission for Science, Technology and Innovation (NACOSTI) in order to conduct the study. Informed consent forms were sought from all the participants that agreed to participate in the study.

The respondents were assured of confidentiality and protection. It was further made clear that the information gathered would solely be used for this study. Each participant's responses was treated in confidence and not released to any other party for whatever reason.

The researcher did not interview anyone outside the study and also did not interview the target sample without a mutual understanding between them. Confidentiality was observed by moving the data in sealed envelopes and ensuring no unauthorized persons accessed the data and only authorized persons had access to the raw data.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter presents the results and findings of this study. The chapter is divided into the following sub-sections: response rate, characteristics of the farmers, contribution of land size to adoption of PELIS, socioeconomic factors contributing to the adoption of PELIS, contribution of payment of forest plot fees to the adoption of PELIS, contribution of stakeholder engagement to the to the adoption of PELIS, and contribution of independent variables to the dependent variable.

4.2 Response Rate

The target population of the study was 240 respondents, out of whom 127 respondents filled and returned their questionnaire giving a response rate of 85%. This was considered quite sufficient for data analysis and generalization of the findings to the target population. Mugenda (2003), recommended a response rate of at least 50% to be adequate. The response rate was therefore fit enough for carrying out study analysis.

Table 4.1: Response Rate

Number of questionnaires administered	Number of questionnaires filled and returned	Response rate (Percent)
240	127	85

The proceeding section of this chapter, study findings together with relevant discussions are presented, starting with the requisite demographic information of respondents.

4.2 Characteristics of the Farmers in Kibirichia

Prior to analysis of data on specific objective areas, the study preliminarily analysed essential background information to form basis for subsequent inferences. The particular data included respondents'; gender, age, level of education, marital status, and occupation.

4.2.1 Sex of the Respondents

The sex of the respondents was observed during the interview and recorded. The information was then analysed and the results are presented in Table 4.2.

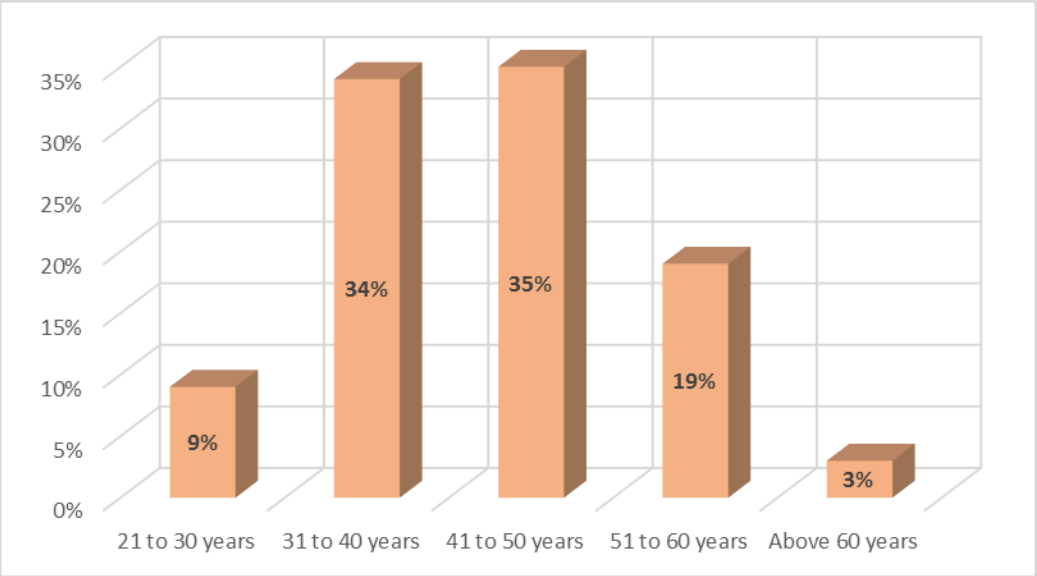
Table 4.2: Sex of Respondents

Sex	Frequency	Percentage
Male	103	81
Female	24	29
Total	**127**	**100**

The results in Table 4.2 show that the majority (81 %) of the respondents were male, while 29 % were female. The males were the majority in the involvement of PELIS system of farming in the degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

4.2.2 Age of the Farmers Participating in PELIS

The farmers were asked to state their ages and the information was analysed and is presented in Figure 4.1.



n=127

Figure 4.1: Age categories of the Farmers

As indicated in Figure 4.1, 35 % of the respondents were between 41-50 years; 34% were between 31 - 40 years; 19 % were between 51-60 years, 9% were 21 – 30 years and 3% were above 60 years. This indicates that the majority of the respondents reached for the study were in the age bracket of 31 to 50 years.

4.2.3 Formal Educational Level of the Farmers

The household heads were asked to state the highest education level they had attained, the information was then analysed and the results are shown in Table 4.3.

Table 4.3: Highest Education Level Attained by the Farmers

Formal Education Level	Frequency	Percent
Illiterate	42	33
Primary School	66	52
Secondary School	16	12
College	2	2
University	1	1
Total	**127**	**100**

The majority (52 %) of the respondents had attained the primary level of education, while 33 % were illiterate; 12 % had attained the secondary level; 2 % indicated college and 1% indicated University. The study revealed that majority of the respondents in the study involved in farming had some basic form of education and could therefore understand and participate in the study. For the minor section that was illiterate, the study hired interpreters to assist with collection of data from them.

Moreover, the KIIS noted that:

> "Majority of the respondents are illiterate (never attended school) or semi-illiterate (class 8 drop-outs and high school dropouts). The implication of this is that respondents don't have adequate knowledge on the importance of forest cover and hence state of water in the country altogether. Currently: water capacity is 650m^3 against the global requirement of 1000m^3 per capita per year bearing in mind this classes Kenya as a water scarce country."

4.2.4 Year's Participated in PELIS System

The farmers were asked to state the number of years they had stayed in the PELIS scheme, the data was analysed and the frequency distribution are shown in Figure 4.2.

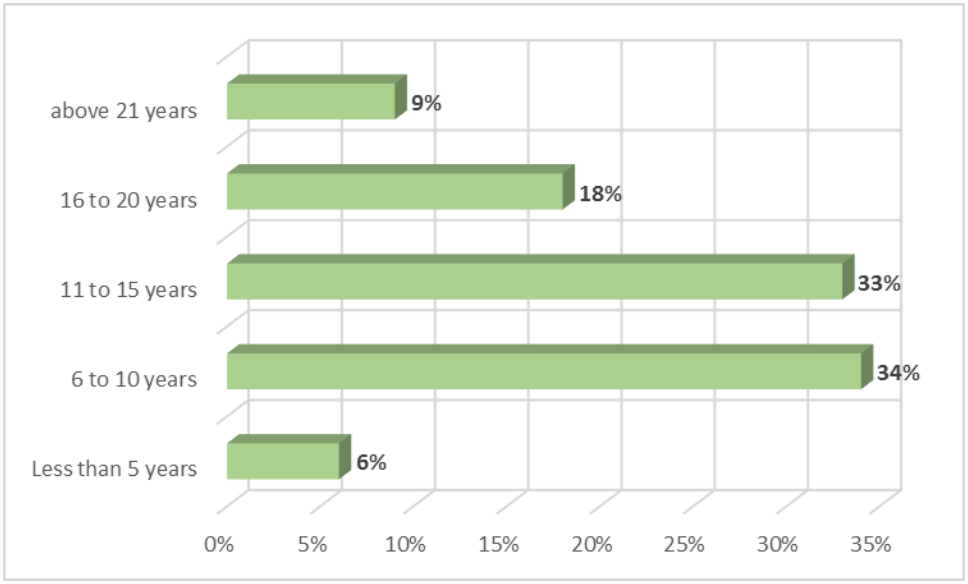


Figure 4.2: Number of Years the farmers had practised Farming in the PELIS system

As illustrated in Figure 4.2 above, 34% of the respondents indicated that they had practiced farming for 6-10 years; 33% indicated that they had practiced farming for 11-15 years; 18% of the respondents indicated that they had practiced farming for 16-20 years; 9% of the respondents indicated that they had practiced farming for over 21 years; and 6% of the respondents indicated that they had practiced farming for less than 5 years. This implies that majority the respondents who participated in the study had been into farming for a long period of time (above 6 years) and therefore they were a rich source of information.

4.2.5 Farmers Awareness of the PELIS System

The Farmers were asked if they were aware of the availability of the PELIS system. The results are presented in Table 4.4.

Table 4.4: Farmers Awareness of the PELIS System

	Frequency	Percent
Aware of PELIS	127	100.0

Table 4.4 indicates that all the respondents affirmed that they were aware of the shamba systems. This portrays that the study had been able to reach an informed audience boosting the credibility of the findings.

4.3 Contribution of the Size of Land Owned by the Farmers on the Adoption of PELIS by Farmers

The first objective of the study was to investigate the effects of the size of land owned by the farmer on the adoption of PELIS in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. The respondents were

queried on a series of issues to assess this effect. To begin with, the respondents were requested to indicate the size of the land that they own (Ha)

Table 4.5: Size of Land Owned by Respondents in Ha

Number of Years	Frequency	Percent
0-1	89	70
2-3	28	22
4-5	7	6
6 and above	3	2
Total	**127**	**100**

The findings tabulated in Table 4.5 reveal that majority (70 %) of the respondents own 0-1 Ha of land, 28 own 2-3 Ha of land, 7 own 4-5 Ha of land while 3 own 6 and above Ha of land. This shows that majority of the respondents owned small size of land (0-1Ha).

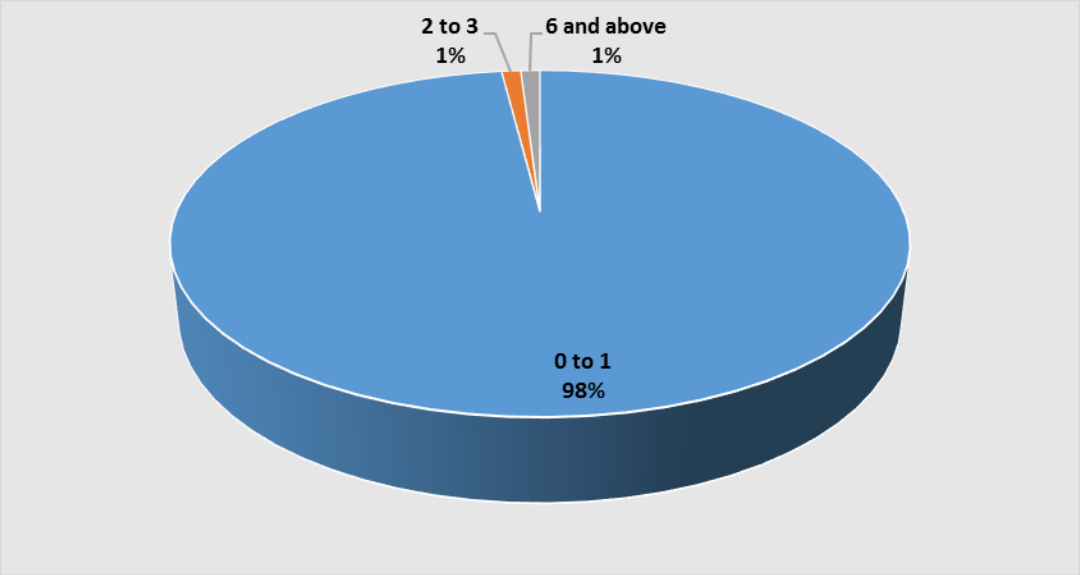


Figure 4.3: Size of Land given to Respondents by PELIS in Ha

Figure 4.3 goes on to show the proportion of land given to the respondents by PELIS in Ha. Majority of the respondents stated that they were given 0 – 1 Ha of land, while the remaining (1%) were given 2 – 3 Ha and 6 and above Ha of land each. This indicates that all the respondents of the study were given land by PELIS and therefore the information they provided could be relied upon.

Table 4.5: Other Land in Use by the Farmers

	Frequency	**Percent**
Other land available	68	54
No other land available	59	46
Total	**127**	**100**

The results (Table 4.5) established that 54 % of the respondents had other land in use while 46 % of the respondents did not. This implies that most of the respondents had diversified their land ownership besides the PELIS option. These other lands owned by the farmers were acquired through either one of the following methods: renting, acquiring, borrowing, and inheriting (as shown in Figure 4.4)

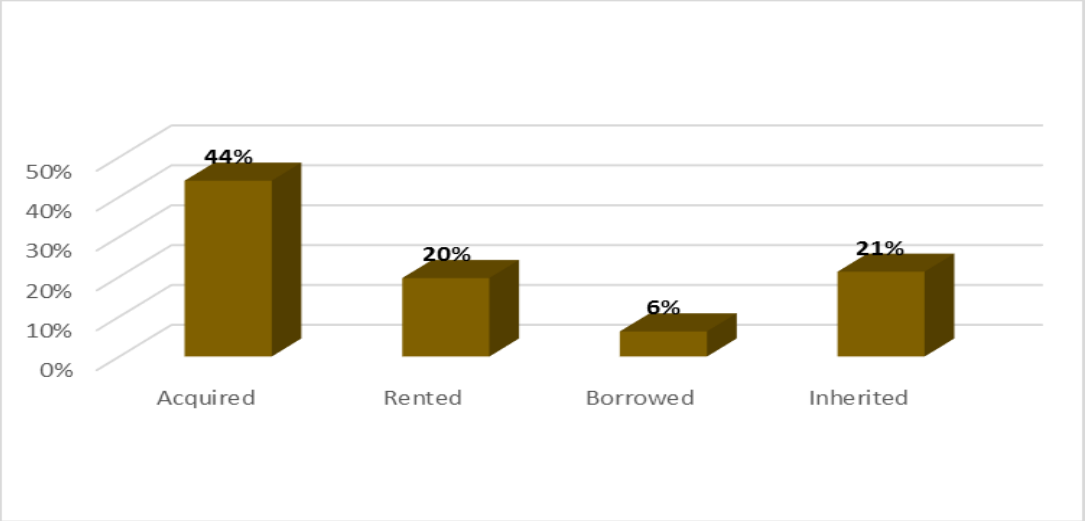


Figure 4.4: How Respondents Acquired Other Land

In addition to the revelation that the respondents had other land in use, the study determined that 44% of this respondents had bought the other piece of land, 21% had inherited it, 20% had rented it and 6% had borrowed it. This implies that the respondents had other option of acquiring land besides the PELIS option.

4.3.2 Contribution of Land Size to Adoption of PELIS by the Farmers

The contribution of land size to the adoption of PELIS by farmers was determined by asking the respondents to rate a series of statements on how land size affects the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya. The farmers rated the statements on a scale of 1 to 5, where 1 was rated as strongly disagree and 5 was rated as strongly agree to the statement. The findings are as presented in Table 4.6.

Table 4.6: How Land Size Contributes the Adoption of PELIS by Farmers;

Statement	Mean	Std. Dev
Land size determines the extent to which the farmers will use their land for the adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS)	3.70	.827
Land size is also a critical agricultural production factor for modern technology agricultural adoption	3.80	.477
Small scale farmers with smaller land pieces, lack of enough resources to adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS)	3.82	.892
Land size is a very critical agricultural production resource that influences technology adoption by farmers	3.83	.880
Grand Mean	3.78	.120

n=127

According to the findings, majority of the respondents generally agreed that land size affects the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya.

Specifically, findings on land size is a very critical agricultural production resource that influences technology adoption by farmers generated a mean of 3.83 and standard deviation of .880. Small scale farmers with smaller land pieces, lack of enough resources to adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS) had a mean of 3.82 and standard deviation 0.892. Land size is also a critical agricultural production factor for modern technology agricultural adoption had a mean of 3.80 and standard deviation of 0.477. Land size determines the extent to

which the farmers will use their land for the adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS) had a mean of 3.70 and standard deviation of 0.827.

This implies that the factor of land size affects the adoption of PELIS due to its ability to enable agricultural production. Moreover, the small sizes of land owned by the farmers facilitate the adoption of PELIS as it offers an opportunity to increase agricultural production.

The KIIS also revealed that:

> "The small pieces of land in the area have increased the rate of participation in the shamba system hence the restoration of forest cover. Moreover, there is only (1) type of season practiced under PELIS. Food crops are grown allowed in Marania. Reason and tenancy is temporary and perennial crops cannot thrive. It's also a way of preventing a situation where the occupants/cultivators are tempted to assume absolute ownership of the plots (the slots given are ¼ or *robos* as they call it). E.g. plant perennial crops such as coffee/tea crops."

4.4 Contribution of Social Economic Factors on the Adoption of PELIS by Farmers

The second objective of the study was to assess the effects of Social economic factors on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. Table 4.7 summarizes the findings on the level of respondent's agreements with statements relating to the effects of social economic factors on the adoption of PELIS by farmers.

Table 4.7: How Socio-economic Factors Contributes to the Adoption of PELIS by Farmers

Statements	Mean	SD.
The farmer's age influences the decision of farmer either to adopt PELIS	3.70	.788
Level of education of farmers influences the decision of farmer either to adopt PELIS	3.78	.752
Social groupings determine how the farmers will adopt the existing modern technologies	3.79	.671
The gender of farmers influences the adoption of PELIS	3.84	.597
Grand mean	3.77	.299

n=127

The findings revealed that majority of the respondents agreed that Social economic factors indeed affect the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya by high mean score values of most statements.

The gender of farmers influences the adoption of PELIS generated a mean of 3.75 and standard deviation of 0.700. Social groupings determine how the farmers will adopt the existing modern technologies had a mean of 3.795 and standard deviation 0.671. Level of education of farmers influences the decision of farmer either to adopt PELIS had a mean of 3.787 and standard deviation of 0.752. The farmer's age influences the decision of farmer either to adopt PELIS had a mean of 3.709 and standard deviation of 0.788.

According to the KIIs.

> "A huge number of the residents are farmers hence they are willing to participate in the shamba system so as to increase their income."

This infers that, socio economic factors of gender, social groupings, education level and farmers age are a key determinant of the adoption of PELIS because, they determine the respondents understanding of the objectives of the system as well as its benefits. By comparing this info to their current needs, respondents are thus able to adopt the PELIS system.

4.5 The Contribution of Payment of Fees on the Adoption of PELIS by Farmers

The third objective was to determine the effects of payment of fees on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. To fulfil this objective, respondents were required to describe the ways in they are involved in payment of fees for PELIS and rate a series of statements on how payment of fees affect the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya.

The findings in table 4.8 depict that all respondents agreed that farmers are involved in payment of fees through use of land. This is in line with the objective of the PELIS system.

Table 4.82: Ways in which Respondents are Involved in Payment of Fees for PELIS;

Payment of fees for the following	Frequency	Percent
Use of land	127	100

According to the findings on the respective means for the various statements in Table 4.9, payment of fees generally affected the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya.

Table 4.9 How Payment of Fees contributes to the Adoption of PELIS by Farmers

Statements	Mean	SD
Intercropping of young trees with food crops is beneficial in terms of tree survival which will otherwise reduce the cost	3.72	.903
To ensure enhancement of accountability and transparency when formulating regulations and guidelines for cost–benefit sharing mechanisms	3.72	.903
One benefit of shamba system is low cost of plantation establishment.	3.86	.616
Food crop plantation will provide income to the peasant farmers and reduction of forest plantation establishment costs.	3.92	.570
Grand Mean	3.85	.422

n=127

Specifically, findings on food crop plantation will provide income to the peasant farmers and reduction of forest plantation establishment costs generated a mean of 3.92 and standard deviation of 0.570. One benefit of shamba system is low cost of plantation establishment had a mean of 3.85 and standard deviation 0.616. To ensure enhancement of accountability and transparency when formulating regulations and guidelines for cost –benefit sharing mechanisms had a mean of 3.72 and standard deviation of 0.903. Intercropping of young trees with food crops is beneficial in terms of tree survival which will otherwise reduce the cost had a mean of 3.72 and standard deviation of 0.903.

The KIIs noted that;

> "Payment of fees offers an opportunity for the maintenance of plots as well as the purchase of seedlings for the planting of trees. However, most of the farmers were to be unwilling to pay for any fees partly due to their ownership of the forest."

The findings depict that, payment of fees was based on the rationale of a win-win situation for the farmers and the Kenya forest. The farmers benefit by selling the produce they cultivate on the allocated land whereas the KF benefits by increasing their source of income from the collection of revenue from the farmers. Payment of fees also enables the KF to acquire seedling for tree plantation. However, the payment of fees factor encountered challenges of compliance from the farmers hence inhibiting the effective adoption of the PELIS system. This forms a basis for drawing recommendations on ways to enhance compliance with payment of fees and hence adoption of the PELIS system.

4.6 The Contribution of Capacity-Building to the Adoption of PELIS

The fourth objective of the study was on the effects of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. In relation to this objective, the respondents were expected to shed light on the frequency of their participation in various forms of capacity building as well as rating a series of statements on how does capacity-building the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

Table 4.10: Contribution of Capacity Building on the Adoption of PELIS by Farmers

Statement	Mean	SD
Ongoing capacity development through professional education and training of shamba systems enhances rehabilitation and restoration of degraded forests	3.69	.624
Strengthening people's capacity through shamba systems enhances rehabilitation and restoration of degraded forests	3.89	.433
Agroforestry needs to mobilize human and institutional capacity in rehabilitation and restoration of degraded forests	3.95	.452
Capacity-building ensures that neighbouring countries, and even institutions within the same country	3.96	.487
Nursery managers and staff should be trained and supported to produce high-quality seedlings with the best possible chance of establishing rehabilitation and restoration of degraded forests	3.97	.367
Grand Mean	3.89	.522

n=127

The findings on how capacity-building affects the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya are as tabulated in Table 4.10. It is evident that capacity-building affects the adoption of PELIS by farmers in degraded forest areas based on the mean scores for the statements provided. For instance, nursery managers and staff should be trained and supported to produce high-quality seedlings with the best possible chance of establishing rehabilitation and restoration of degraded forests generated a mean of 3.97 and standard deviation of 0.367. Capacity-building ensures that neighbouring countries, and even institutions within the same country generated a mean of 3.96 and standard deviation of 0.487. Agroforestry needs to mobilize human and institutional

capacity in rehabilitation and restoration of degraded forests generated a mean of 3.95 and standard deviation of 0.452. Strengthening people's capacity through shamba systems enhances rehabilitation and restoration of degraded forests generated a mean of 3.89 and standard deviation of 0.433. Ongoing capacity development through professional education and training of shamba systems enhances rehabilitation and restoration of degraded forests generated a mean of 3.69 and standard deviation of 0.624.

The KIIs observed that;

> "Capacity building enhances the adoption of the PELIS system since capacity building has direct reflection on understanding of the implementation of PELIS and hence its success. Capacity building also enhances forest conservation as the farmers are taught various approaches of forest management. Moreover, though capacity building, farmers are well trained on PFM and record keeping."

This portrays that capacity building was a critical factor in the adoption of the PELIS system as it offered a platform for the sensitization of farmers on the objectives and benefits of the system. It also enhances the understanding of the farmers on how the system works.

4.7 Contribution of Stakeholder Engagement to the Adoption of PELIS by Farmers

The fifth objective of the study related to the effects of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. The study requested the respondents to comment on who are the stakeholders of PELIS, the status of stakeholder engagement in the adoption of PELIS by farmers in degraded forest and lastly to rate a series of

statements on how does stakeholder engagement affects the adoption of PELIS by farmers.

As per the KIIs;

> "Stakeholder engagement would enhance the adoption of the PELIS system, facilitates decision making as well as ownership of the program by the local community."

Table 4.11: Contribution of Stakeholder Engagement on the Adoption of PELIS by Farmers

Statements	Mean	SD.
The principal stakeholders should establish a consensus on the trade-offs involved in addressing the drivers of forest degradation	3.78	.890
The principal stakeholders should be engaged on long-term goals of rehabilitation and restoration of degraded	3.92	.457
Stakeholder engagement should engage on forest restoration planning on shamba systems	3.96	.622
The principal stakeholders should be engage on roles and responsibilities and the equitable distribution of incentives, costs and benefits	4.00	.570
Stakeholder engagement should be based on a coordinated, transparent and Participatory Land-use Planning process	4.07	.474
Grand Mean	3.90	

n=127

Table 4.11 illustrates the findings on how stakeholder engagement affects the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. It is clear that stakeholder engagement could generally be said to affect the adoption of PELIS by farmers as shown by the mean score values for the respective statements. Stakeholder engagement is based on a coordinated, transparent and Participatory Land-use Planning process generated a mean of 4.07 and standard deviation of 0.474. The principal stakeholders engage on

roles and responsibilities and the equitable distribution of incentives, costs and benefits generated a mean of 4.00 and standard deviation of 0.570. Stakeholder engagement should engage on forest restoration planning on shamba systems generated a mean of 3.96 and standard deviation of 0.622. The principal stakeholders are engaged on long-term goals of rehabilitation and restoration of degraded generated a mean of 3.92 and standard deviation of 0.457. The principal stakeholders establish a consensus on the trade-offs involved in addressing the drivers of forest degradation generated a mean of 3.78 and standard deviation of 0.890.

Based on the findings, it can be stated that stakeholders engagement are an important catalyst in the adoption of the PELIS system as well as the decision making processes concerning the system. This is because, it ensures that the expectations of all stakeholders are put into consideration when coming up with the aims and objectives of the system. Additionally, it has enabled the community members to own the PELIS initiative.

4.8 Contribution of the Proximity to the Forest on the Adoption of PELIS by Farmers

The sixth and last objective sought to establish the effects of stakeholder engagement on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. The respondents were presented with questions on the distance from home to the PELIS plots and statements on how stakeholder engagement the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

4.8.1 Distance to the Forest from the Household

The farmers were asked to state the distance between their homestead and the forest, the results are summarized in Figure 4.5.

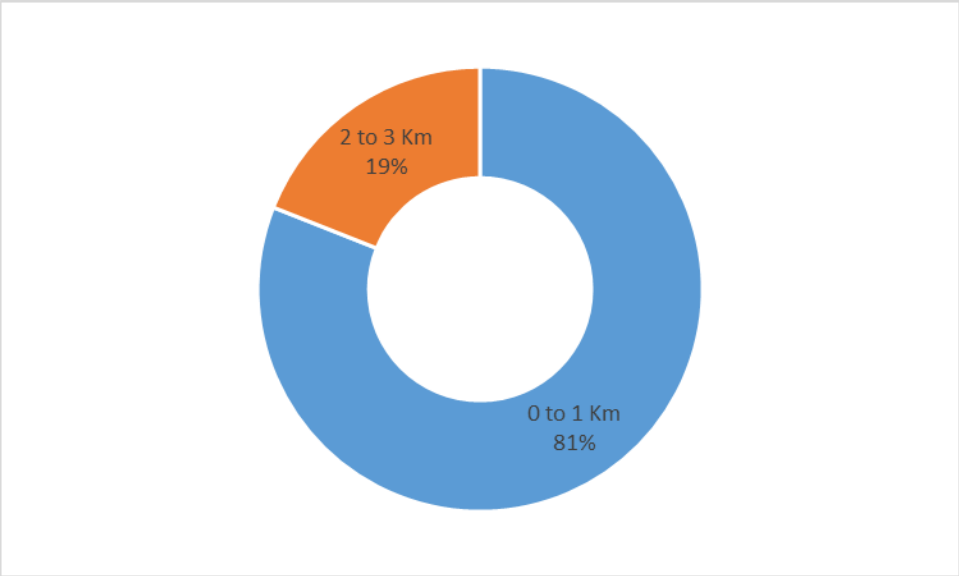


Figure 4.5: Distance from Respondents Home to the PELIS Plots

The distance, as illustrated in Figure 4.5, from the respondents home to the forest for majority (81 %) of the respondents was found to be between 0-1 Km where for 19% of the respondents it was between 2 -3 Km. This shows that the PELIS allocation was made to farmers living close to the forest.

4.8.2 Contribution of the Distance to the Forest plots from the Farmers Homesteads to the Adoption of PELIS

The contribution of the distance to the forest plots from the farmer's homesteads to the adoption of PELIS by farmers was determined by asking the farmers to rate statements related to the variable distance from the forest plots to the famer's homesteads on a scale of 1 to 5. 1 being strongly disagreed and 5 being strongly agreed. The scores were then summed up and a mean determined as shown in Table 4.12.

Table 4.12: How Distance from Home affects the Adoption of PELIS by Farmers

Statement	Mean	SD.
The farmers live from the county extension offices where the extension officers	3.74	.642
Agricultural rural income through direct production and other activities related to the collection, processing, and marketing results.	3.75	.651
Access and provision of extension services in Kenya is hampered by the long distances	3.89	.744
Grand mean	3.79	

n=127

As indicated in Table 4.12, distance between farmers homes and the forest affects the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. Specifically, the statements on access and provision of extension services in Kenya is hampered by the long distances had a mean of 3.89 and standard deviation of 0.744. Agricultural rural income through direct production and other activities related to the collection, processing, and marketing results had a mean of 3.75 and standard deviation of 0.651. The farmers live from the county extension offices where the extension officers are based had a mean of 3.74 and standard deviation of 0.642.

According to the KIIs;

> "Most farmers are within a radius of 1km, short distances to the forest enhance the adoption of the PELIS system whereas long distances hamper the same by reducing the time dedicated to work on the shambas."

The findings denote that distance to from respondents home to the forest was a critical element in the allocation of land under the PELIS system. The focus was on a shorter

distance to the forest as it was considered as increasing the productiveness of the farmers due to reduced times spent on travelling to and from their homes and more time spent in cultivation and afforestation of the allocated land.

4.9 Contribution of Independent Variables to the Adoption of the PELIS System by the farmers

The KIIs revealed that participatory forest management has taken root in Marania forest as communities participate in conservation and protection of the forest collectively. All members were involved in planting trees (cycle is 3 to 5 years). The beneficiaries of PELIS include the landless, slum dwellers, former forest workers and the unemployed whose livelihood depended on the forest. The requirements/qualifications to get allotment are that one must be a registered member in CBOs dealing with conservation matters and consequently the CBO must be under CFA (in this case Ntimaka CFA). Moreover, all the cultivators participate in tree planting. The main objective of using the community to participate in forest plantation is to share the benefits of the PELIS system with the forest adjacent communities. The allotees are to cultivate on the exact site of the allocated plots. No extension or encroachment observed.

The Shamba system or non-residential cultivation (NRC) and rebranded as PELIS is working and has generally led to: Poverty reduction through creation of employment and increased food security due to increased levels of food production. Reduction of government expenditure by cutting on the number of staffs (required) and to contribute to environmental conservation due to availability of labour. Kenya Forests

enjoys free labour provided by the community in production and planting of seedlings and maintenance of the same. KFs also benefit from collection from the sale of cultivation permits/renewal permits. Environmental conservation and protection of water catchments through tree planting.

4.10 Regression Analysis

The main objective of the study was to investigate factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya. The study used multivariate regression analysis in establishing this relationship. The dependent variable of the study was adoption of PELIS by farmers in degraded forest areas, while the independent variables were: land size of land owned, social economic factors, payment of fees, capacity-building, stakeholder engagement**,** distance between farmer's homes and the forest. The results from the regression analysis are discussed next.

R-Square is a commonly used statistic to evaluate model fit. R-square is 1 minus the ratio of residual variability as shown in Table 4.13.

Table 4.13: Results of Multiple Regression

R	R Square	Adjusted R Square	Std. Error of the Estimate
.943[a]	0.889	0.883	0.300

a. Predictors: (Constant), land size of land owned, social economic factors, payment of fees, capacity-building, stakeholder engagement**,** distance between farmers homes and the forest

The findings in Table 4.13 of this study indicate that 88.3 % of the changes in adoption of PELIS by farmers in degraded forest areas variables could be attributed to the combined impact of the predictor variables.

The regression model was tested using the F-test to check the fit of the model and the results of the test are shown in Table 4.14.

Table 4.14: ANOVA Table for the Regression Analysis

	Sum of Squares	df	Mean Square	F	p
Regression	86.66	6	14.44	159.63	.001[b]
Residual	10.85	120	.090		
Total	97.52	126			

a. Dependent Variable: Adoption of PELIS
b. Predictors: (Constant), Land Size of land owned, Social Economic Factors, Payment of Fees, Capacity-Building, Stakeholder Engagement**,** Distance between farmers homes and the forest

Table 4.14 reveals that there was a significant relationship between factors and the adoption of PELIS by farmers in degraded forest areas as the F critical at 5 % level of significance was 159.63 since F calculated is greater than the F critical (value = 2.175), this shows that the overall model was significant

The regression coefficients for the multiple regression analysis are shown in Table 4.15.

Table 4.15: Regression Coefficients

	Unstandardized Coefficients		Standardized Coefficients		.
	B	**Std. Error**	**Beta**	**t**	**p**
(Constant)	.770	.383		2.008	.047
Land Size	1.137	.049	.890	23.39	.001
Socio- economic Factors	.140	.082	.099	1.705	.091
Payment of Fees	.189	.094	.118	2.019	.046
Capacity-Building	.236	.093	.089	2.545	.012
Stakeholder Engagement	.294	.092	.134	3.202	.002
Distance to the Forest	.064	.047	.048	1.363	.175

a. Dependent Variable: Adoption of PELIS

The coefficient Table 4.15 shows that there were positive significant ($p<.05$) relationships between land size, payment of fees, capacity building, and stakeholder engagement and the adoption of PELIS by farmers in degraded forest areas. There were no significant ($p>.05$) relationships between social economic factors and the distance to the forest and adoption of PELIS among the farmers.

The results show significant relationships between land size ($\beta=0.890$, $t=23.39$, $p< 0.001$), payment of fees ($\beta=0.118$, $t=2.019$, $p=0.046$), capacity building ($\beta=0.089$, $p=0.012$), and stakeholder engagement ($\beta=.134$, $t=3.202$, $p=0.002$) and the adoption of PELIS by farmers.

Non-significant relationships were found between socio-economic factors (β=0.099, t=1.7005, p>0.05), and distance from the forest plots (β=0.048, t=1.363, p>0.05) and the adoption of PELIS by farmers.

Lastly, the study found out that that 88.3% of the changes in adoption of PELIS by farmers in degraded forest areas variables could be attributed to the combined impact of the predictor variables (independent variables). The factor with highest impact was land size, then stakeholder engagement, followed by capacity building, payment of fees, socio-economic factors and lastly distance from home to the forest.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The research was guided by the following questions:

(i) How does land size of land owned by the farmers on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(ii) What is the contribution of Social economic factors on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(iii) What is the contribution of payment of fees on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(iv) What is the contribution of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(v) What is the contribution of stakeholder engagement on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

(vi) What is the contribution of distance between farmer's homes and the forest on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

The aim of answering the above questions was to investigate factors contributing to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

5.2 Discussion

The discussion in this section will demonstrate the implication of the findings in chapter four and how these link to previous research. Similarities and differences between this study and previous study as well as highlighting new information garnered from this research.

5.2.1 Contribution of Land Size Owned by the Farmers on the Adoption of PELIS

How does land size of land owned by the farmers contribute to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya? The study found out that that land size owned by the farmers significantly contributed to the adoption of PELIS by the famers. This was due to the small sizes of land the farmers owned could not offer the opportunity to increase production, thus facilitating the adoption of PELIS to increase agricultural production.

The factor of land size with the highest effect was found to be its critical nature of an agricultural production resource that influences technology adoption by farmers. This was flowed by small scale farmers with smaller land pieces, lack of enough resources to adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS). Land size is also a critical agricultural production factor for modern technology agricultural adoption. Land size determines the extent to which the

farmers will use their land for the adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS). Likewise, in Bihar India, Singh et al (2014) and Mohammad (2011) found out that small sized land holdings and too much fragmented land were the main limiting factor to the adoption of modern horticultural technologies. Farmers with smaller land holdings will not take any risk to adopt any new technology available.

5.2.2 Contribution of Socio-economic Factors to the Adoption of PELIS by Farmers

What is the contribution of socioeconomic factors on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

The factor of gender with the most significant influence in the adoption of PELIS was found to be gender of farmers, social groupings, level of education of farmers and the farmer's age respectively. This concurs with empirical literature that social factors that have identified to influence the chances of adoption by a farmer include; the farmer's age, level of education, gender and his social groupings. Institutional factors that influence and determine the rate of agricultural technologies adoption and uptake by farmers include; access to information about the technologies through the existing and accessible information sources, nature of policies and provisions enacted by the government and access and nature of the extension services provided (Langat et al., 2013).

5.2.3 Contribution of Payment of Fees on the Adoption of PELIS by Farmers

What is the contribution of payment of fees on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya? The study established that that farmers are involved in payment of fees for the use of forest land. The payment of fees had a statistical significant influence on the adoption of PELIS by the famers.

The payment of forest fees by the farmers was a win-win situation for the farmers and the Kenya Forest Service (KFS). The farmers benefitted by selling the produce they cultivated on the allocated land whereas the KFS benefitted by increasing their source of income from the collection of revenue from the farmers. Payment of fees also enables the KFS to acquire seedling for tree plantation. Therefore, the production of food crops provides income to the peasant farmers and reduction of forest plantation establishment costs. Low cost of plantation establishment. Ensuring enhancement of accountability and transparency when formulating regulations and guidelines for cost–benefit sharing mechanisms. Intercropping of young trees with food crops for tree survival and a reduction in cost.

This concurs with the finding by Monela *et al.*, (1991) on analyzing the Taungya system at the North Kilimanjaro Forest plantation in Tanzania, limited to an examination of costs and revenues resulting from the practice and also the impact the system has on tree survival and food crops yields. The results showed that during the early stages of forest plantation establishment, intercropping of young trees with food crops is beneficial in terms of tree survival, food crop production, financial, income to

the peasant farmers and reduction of forest plantation establishment costs. Therefore the system is suitable and should be sustained.

5.2.4 Contribution of Capacity Building on the Adoption of PELIS by Farmers

What is the contribution of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya? Capacity-building was found to affect the adoption of PELIS by farmers in degraded forest areas particularly in relation to; Nursery managers and staff being trained and supported to produce high-quality seedlings with the best possible chance of establishing rehabilitation and restoration of degraded forests as it offered a platform for the sensitization of farmers on the objectives and benefits of the system. It also enhance the understanding of the farmers of the system works. This ensures that neighbouring countries, and even institutions within the same country conserve forests. Agroforestry mobilizing human and institutional capacity in rehabilitation and restoration of degraded forests. Strengthening people's capacity through shamba systems enhances rehabilitation and restoration of degraded forests. Ongoing capacity development through professional education and training of shamba systems enhances rehabilitation and restoration of degraded forests.

The findings agree with those by Christensen & Lundvall (2017) that ongoing capacity development through professional education and training, extension support services and the strengthening of national research capabilities is essential for improving planning, management and technical decision-making on forest restoration and rehabilitation and to enable organizations to understand and respond to the

priority needs and aspirations of stakeholders. In particular, nursery managers and staff should be trained and supported to produce high-quality seedlings with the best possible chance of establishing in the field and growing rapidly when planted out in the often difficult environment of a deforested or degraded site.

5.2.5 Contribution of Stakeholder Engagement on the Adoption of PELIS by Farmers

What is the contribution of stakeholder engagement on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya? The study revealed that that stakeholder engagement affects the adoption of PELIS by farmers when; Stakeholder engagement is based on a coordinated, transparent and Participatory Land-use Planning process (PLP). This provides the decision making processes concerning the system. This is because, it ensures that the expectations of all stakeholders are put into consideration when coming up with the aims and objectives of the system. Additionally, it has enabled the community members to own the PELIS initiative.

The principal stakeholders engage on roles and responsibilities and the equitable distribution of incentives, costs and benefits generated a higher mean. Stakeholder engagement entails forest restoration planning on shamba systems. The principal stakeholders are engaged on long-term goals of rehabilitation and restoration of forests. The principal stakeholders establish a consensus on the trade-offs involved in addressing the drivers of forest degradation.

This finding agrees with the recommendation by Dudley (2006) that Forest restoration planning, evaluation, management and implementation are major and urgent challenges for forest health and sustainable development in the United States and many other regions of the world (Dudley, 2006). Forest managers, stakeholders and private landowners need to use all possible means to assist in this important undertaking.

5.2.6 Contribution of Distance from Forest Plots to Farmers Homesteads to the Adoption of the PELIS by Farmers

What is the contribution of distance between farmer's homes from the forest plots on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya? The study determined that the distance had no statistical significant influence on the adoption of PELIS by farmers. This is a critical element in the allocation of land under the PELIS system. The focus was on a shorter distance to the forest as it was considered as increasing the productiveness of the farmers due to reduced times spent on travelling to and from their homes and more time spent in cultivation and afforestation of the allocated land.

Moreover, distance between farmers homes and the forest was found to affect the adoption of PELIS by farmers because; access and provision of extension services in Kenya is hampered by the long distances, agricultural rural income through direct production and other activities related to the collection, processing, and marketing results. The farmers living close to county extension offices where the extension officers are based.

Foresta and Michon (2014) also found out that the delivery of extension services is also negatively affected by low budgetary allocation to the government departments involved in extension, few extension officers covering bigger regions and lack adequate facilitation for the extension officers with reliable means of transport. This therefore means that the officers are unable to make frequent visits to the farmers for follow ups also the current Government policy of farmer demand driven extension which the study found out is mostly being applied by all the extension officers who responded require the farmers to visit the extension offices to seek for the extension services on contrary with the doctor- patient model.

5.4 Conclusions

The following conclusions were made from this study:

(i) The size of land owned by the famers had statistical significant contribution to the adoption of PELIS by farmer in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

(ii) Socioeconomic factors had no significant contribution to the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya

(iii) Payment of farm fees was found to have a statistical significant influence on the adoption of PELIS by the farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya

(iv) Capacity Building was found to have a statistical significant contribution to the adoption of PELIS by the farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya

(v) Distance of forest plots from the famers homestead was found to have no statistical significant relationship to the adoption of PELIS by the famers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya.

5.5 Recommendations

In order to effectively increase the impact of the PELIS system, it was recommended that an elaborate Participatory Land Use Planning (PLUP) process be undertaken by all the stakeholders in order to enhance the sustainability of the PELIS system as it is beneficial to the farmers and the Forest conservation initiatives in the area. The following activities and considerations should be taken into account during the planning process:

(i) Develop a sustainability model on PELIS and present the intended outcomes.

(ii) Discourage the ownership of forest land so as to facilitate the adoption of the PELIS system because under this system, once the tree cover has been established farmers are allocated other pieces of land to continue with the process of forest cover.

(iii) Community participation/stakeholder participation at various levels. Monitoring and evaluation needs to be enhanced for progressive strategy such as PELIS implementation (PCCA E)

(iv) Capacity building needs to be enhanced. Low/no seminars-no record of trainings or seminars for members on record keeping.

(v) Close monitoring to be done in order to enhance the success of PELIS.

(vi) Physical counting of planted trees in order to establish the survival rate. Enhance beating up in case of tree failure.

(vii) The options for the world's forest landscapes is of Mt. Kenya forest within Marania (Kibirichia) location in Buuri sub county, Meru County to be set as; Agroforestry systems and natural regeneration and to be well conserved and to be models for future generations.

(viii) Some goods and services need to be provided to Mt Kenya Forest such as; Goods: Water, fuel, food. Services: Tourist attraction, air purification, community fencing, free labour for tree planting, cultivators/stakeholders to implement PELIS.

(ix) The future of the forest landscapes should be aimed at increased, well conserved and maintained forest cover.

5.6 Areas of Further Research

There were important issues that emerged during this study and were not able to be addressed due to its scope. In view of this, the following areas are suggested for further research.

i. Have a PELIS pilot plot in Marania and another one in a location where there is no adoption and undertake a comparative analysis.

REFERENCES

Albertazzi, S., Bini, V., Trivellini, L. (2018). Relations of power driving tropical deforestation: a case study from the Mau Forest (Kenya) Belgio: Belgium Journal of Geography 11: https://doi.org/10.4000/belgeo.24223

Agrawal, A. & Gibson, C. (2009). Enchantment and disenchantment: The role of community in natural resource conservation. *World Development*, 27(4), 629-649.

Ann, P. (2017). *Capacity Building in Social Justice Organizations*, Ford Foundation. Capacity building.

Basweti C, Lengkeek A, Prytz P & Jaenicke H (2015). *Tree nursery trade in urban and peri-urban areas. A survey in Nairobi and Kiambu Districts, Kenya*. RELMA Working Paper No. 13. Regional Land Management Unit, Swedish International development Cooperation Agency. Nairobi

Bensel T. G, (2018). Rural woodfuel production for urban markets: problems and opportunities in the Cebu province, Philippines, *Pacific Asian Journal.* 5, 9–28.

Berkes, F. & Seixas, C. (2017). *Lessons from community self-organization and cross-scale linkages in four equator initiative projects.* Joint Project with the International Development Research Center and the UNDP. Winnipeg, Canada: Centre for Community-Based Resource Management, Natural Resources Institute, University of Manitoba.

Berkes, F. (2017). Rethinking community based conservation. *Conservation Biology*, 18(3), 621-630.

Block, W., Franklin, A., Ward, J., Ganey, J., & White, G., (2015). Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife. *Restoration Ecology.* 9(3): 293-303.

Christensen, JL & Lundvall, B-A (2017). *Product Innovation, Interactive Learning and Economic Performance*. Amsterdam: Elsevier.

Cooper, D. R., & Schindler, P. S. (2003). *Business Research Methods*. (8th edition). USA: McGraw-Hill.

De Rouw, A., (2018). The fallow period as a weed-break in shifting cultivation (tropical wet forests). *Agriculture, Ecosystems & Environment*, 54, 31–43.

Dewees, P., Place, F., Scherr, S.J. & Buss, C. (2011). *Investing in trees and landscape restoration in Africa: what, where, and how*. Program on Forests (PROFOR). Washington, DC, USA.

Dudley F, (2006), *Forest Restoration in Landscapes. Beyond Planting Trees*. Springer, New York, pp. 150-158.

Eade, D. & Suzanne, W. (2018). *The four basic steps in the training process.* The Oxfam handbook of development and relief. Oxford: Oxfam.

Ehrenfeld JG. (2014). Defining the limits of restoration: the need for realistic goals. *Restoration Ecology*. 8:2-9.

Elliott S, & Kuaraksa C. (2008). Producing Framework Tree Species for Restoring Forest Ecosystems in Northern Thailand. *Small scale Journal.* 7(7):403–415

Evans, J. (2009). *Planted forests: uses, impacts, and sustainability*. CAB International and FAO.

FAO. (2011). *Assessing forest degradation. Towards the development of globally applicable guidelines.* Forest Resources Assessment Working Paper 177. Rome, Italy.

Government of Kenya (2005). The Forest Bill No. 19 2005; Kenya Gazette Supplement No.45; Government printer, Nairobi, Kenya.

Hobbs RJ, & Harris JA. (2015). Restoration ecology: repairing the earth's ecosystems in the new millennium. *Restoration Ecology* 9:239-246.

Hooper DU, Chapin FS III, Ewel JJ, Hector A, & Inchausti P (2005). *Effects of biodiversity on ecosystem functioning: a consensus of current knowledge.* Ecological Monographs 75:3-36.

Jaetzold R.: (1987). *The Agro-Ecological Zones of Kenya and their Agro-Economical Dynamics*. Geographische Gesellschaft Universitat Trier

Kagombe J.K, (2014). *Contribution of PELIS in Increasing Tree Cover and Community livelihood in Kenya.* KEFRI, Nairobi Kenya.

Kagombe, J.K & J. Gitonga, (2005): *Plantation Establishment System in Kenya-Shamba System Case Study*. Nairobi, Kenya.

Kellert, M., Audouin, M., & Weaver, A. (2010). Advancing sustainability science in South Africa. *South African Journal of Science*, 102, 379-384.

Kothari C.R. (2004). *Research Methodology, Methods and Techniques*. New Delhi New Age International Limited.

Loreau M, Naeem S, & Inchausti P, (2002). Biodiversity and ecosystem functioning: synthesis and perspectives. Oxford (UK): Oxford University Press.

Maathai, W. (2010). Challenge for Africa. *Sustainability Science*. 6(1), 1-2

Machmer, M. & Steeger, C. (2002). Effectiveness Monitoring Guidelines for Ecosystem Restoration. Prepared for the Habitat Branch, *Ministry of Water, Land and Air Protection, by Pandion Ecological*

Mathu W., (2011). *Forest Plantation and Woodlots in Kenya.* African Forest Forum, Nairobi, Kenya

Michon, G., Mary, F. & Bompard, J.M. (2012). Multistoried agroforestry garden system in West Sumatra, Indonesia. *Agroforestry Systems* 4, p. 315-338.

Ngechu. M. (2004), *Understanding the research process and methods. An introduction to research methods.* Acts Press, Nairobi.

OECD (2014) *Knowledge Management in the Learning Society*. Paris: Organization for Economic Co-operation and Development (OECD), p. 23.

Orodho J. A. (2002). *Techniques of Writing Research Proposals and Reports in Education and Social Sciences*. Nairobi: Masola Publishers

Pearson, J. (2011) Training and Beyond: Seeking Better Practices for Capacity Development, *OECD Development Co-operation Working Papers, No. 1*. Paris: Organization for Economic Co-operation and Development (OECD).

Pye-Smith C. 2010. *The Fruits of Success: A programme to domesticate West and Central Africa's wild fruit trees is raising incomes, improving health and stimulating the rural economy*. ICRAF Trees for Change no. 4. Nairobi: World Agroforestry Centre.

Raintree, J. B. (2012) *An Introduction to Agro-forestry Diagnosis and Design.* International Council for Research in Agro-forestry, Kenya

Sayer, J.A. and Maginnis, S. (2005). *Forests in landscapes. Ecosystem approaches to sustainability*. IUCN and Earthscan, UK.

Sonwa, J., Nkongmeneck, B. A., Weise, F., Tchatat, M., Adesina, A., & Janssens, M. J. (2007). Diversity of plants in cocoa agroforests in the humid forest zone of Southern Cameroon. *Biodiversity and Conservation*, *16*(8), 2385-2400.

Temu, A. and D. Garrity (2003). *Building Institutional Capacity to Enhance the Adoption of Innovations: Experiences of the World Agroforestry Centre. United Nations Conference on Technology Transfer and Capacity Building*. Trondheim, Norway.

United Nations Development Programme (2010). *Supporting Capacity Building the UNDP*. Approach. UNDP.

Van Rees, K. (2008). Developing a national agroforestry and afforestation network for Canada. *Policy Options*. 29: 54–57

Zedler, J. (2007). Success: An unclear, subjective descriptor of restoration outcomes. *Ecological Restoration* 25(3): 162-168.

APPENDICES

Appendix A: Letter of Transmittal

Dear Respondent,

RE: ASSESMENT OF FACTORS CONTRIBUTING TO THE ADOPTION OF PELIS BY FARMERS IN DEGRADED FOREST AREAS OF MARANIA IN MOUNT-KENYA FOREST, MERU COUNTY, KENYA

I am a Master of Science in Environment and Natural Resources management, The African Nazarene University currently conducting a research study as entitled above.

I wish to inform that you have been selected as one of the respondents to assist in providing the essential data and information for this activity. I kindly request you to spare a few minutes and answer the attached questionnaire. The information obtained will be used for academic purposes only, will be treated with utmost confidentiality and will not be shared with anyone whatsoever. Do not write your name anywhere on the questionnaire.

I therefore plead you to respond to all questions with utmost honesty.

Thank you, most sincerely for your support.
Yours Sincerely,

Muthamia Jackson Munoru

Appendix B: Household Questionnaire

The information provided will only be for the purpose of this study. Read carefully and give appropriate answers by ticking or filling the blank spaces. The information will be treated as confidential.

Part One: farmers' demographic information

1. What is your gender? (tick one)
   Male ( ) Female ( )
2. What is your age in years? …….
3. What is your level of formal schooling background?
   Illiterate [ ] primary school [ ] secondary [ ]
   College [ ] university [ ]
4. How many years have you done farming? .....
5. Are you aware of the shamba systems?
   Yes ( ) No ( )
6. What is the length of time in shamba system? .....

Part Two: Factors contributing to the Adoption of PELIS by Farmers in degraded Forest areas of Marania (Kibirichia) in Mount-Kenya Forest, Meru County, Kenya

Part A. Effects of land size on the adoption of PELIS by farmers

7. What is the size of the land that you own? (Ha)
   ……..
8. What is the size of land given under PELIS? (Ha)
   ……..

9. Do you have any other land that are using? Yes ( ) No ( )

   If yes, how have you acquired?

Acquired	What is the area?
Rented ( )	
Borrowed ( )	

10. Using a rating scale of 1-5, with 1 being 'to no extent at all', 2 'to a small extent' 3 'to some extent', 4 'to a high extent' and 5 'to a very high extent', how does land size the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya? Please tick (✓) all as appropriate

Factors Under Consideration	**1**	**2**	**3**	**4**	**5**
Land size is a very critical agricultural production resource that influences technology adoption by farmers					
Small scale farmers with smaller land pieces, lack of enough resources to adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS)					
land size determines the extent to which the farmers will use their land for the adoption of Plantation Establishment and Livelihood Improvement Scheme (PELIS)					
Land size is also a critical agricultural production factor for modern technology agricultural adoption					

Part 3: effects of Social demographic factors on the adoption of PELIS by farmers

11. Using a rating scale of 1-5, with 1 being 'to no extent at all', 2 'to a small extent' 3 'to some extent', 4 'to a high extent' and 5 'to a very high extent',

how does Social economic factors the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya? Please tick (✓) all as appropriate

Factors Under Consideration	**1**	**2**	**3**	**4**	**5**
The farmer's age influences the decision of farmer either to adopt PELIS					
Level of education of farmers influences the decision of farmer either to adopt PELIS					
The gender of farmers influences the adoption of PELIS					
Social groupings determine how the farmers will adopt the existing modern technologies					

Part 4: Effects of payment of forest charges/fees on the adoption of PELIS by farmers.

12. In what ways are you involved in payment of fees for PELIS?

Payment of fees for the following	Tick
Use of land	
Supply of seeds	
Supply of water	

13. Using a rating scale of 1-5, with 1 being 'to no extent at all', 2 'to a small extent' 3 'to some extent', 4 'to a high extent' and 5 'to a very high extent', how does payment of fees the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya? Please tick (✓) all as appropriate

Factors Under Consideration	1	2	3	4	5
Intercropping of young trees with food crops is beneficial in terms of tree survival which will otherwise reduce the cost					
One benefit of shamba system is low cost of plantation establishment.					
To ensure enhancement of accountability and transparency when formulating regulations and guidelines for cost –benefit sharing mechanisms					
Food crop plantation will provide income to the peasant farmers and reduction of forest plantation establishment costs.					

Part 5: The effects of capacity-building on the adoption of PELIS

14. How often do you do the following capacity building?

Capacity building	NO.	Location	Duration	Topic
Training				
Seminars				
Demonstration				
Provision of inputs				

15. Using a rating scale of 1-5, with 1 being 'to no extent at all', 2 'to a small extent' 3 'to some extent', 4 'to a high extent' and 5 'to a very high extent', how does capacity-building the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya? Please tick (✓) all as appropriate

Factors Under Consideration	1	2	3	4	5
Agroforestry needs to mobilize human and institutional capacity in rehabilitation and restoration of degraded forests					
Ongoing capacity development through professional education and training of shamba systems enhances rehabilitation and restoration of degraded forests					
Nursery managers and staff should be trained and supported to produce high-quality seedlings with the best possible chance of establishing rehabilitation and restoration of degraded forests					
Strengthening people's capacity through shamba systems enhances rehabilitation and restoration of degraded forests					
capacity-building ensures that neighbouring countries, and even institutions within the same country					

Part 6: Effects of stakeholder engagement on the adoption of PELIS by farmers in degraded forest

16. Who are the stakeholders of PELIS?

……

17. Are the stakeholder engagement involved in the adoption of PELIS by farmers in degraded forest?

Yes ( ) No ( )

18. Using a rating scale of 1-5, with 1 being 'to no extent at all', 2 'to a small extent' 3 'to some extent', 4 'to a high extent' and 5 'to a very high extent', how does stakeholder engagement the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya? Please tick (✓) all as appropriate

Factors Under Consideration	**1**	**2**	**3**	**4**	**5**
The principal stakeholders should be engaged on long-term goals of rehabilitation and restoration of degraded					
The principal stakeholders should be engage on roles and responsibilities and the equitable distribution of incentives, costs and benefits					
The principal stakeholders should establish a consensus on the trade-offs involved in addressing the drivers of forest degradation					
Stakeholder engagement should engage on forest restoration planning on shamba systems					
Stakeholder engagement should be based on a coordinated, transparent and Participatory Land-use Planning process					

Part 7: Effects of proximity to the forest on the adoption of PELIS by farmers in degraded forest

19. What is the distance from home to the PELIS plots?

…….. km

20. Using a rating scale of 1-5, with 1 being 'to no extent at all', 2 'to a small extent' 3 'to some extent', 4 'to a high extent' and 5 'to a very high extent', how does stakeholder engagement the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya, Meru County, Kenya? Please tick (✓) all as appropriate Please tick (✓) all as appropriate

Factors Under Consideration	**1**	**2**	**3**	**4**	**5**
Access and provision of extension services in Kenya is hampered by the long distances					
The farmers live from the county extension offices where the extension officers					
Agricultural rural income through direct production and other activities related to the collection, processing, and marketing results.					

Appendix C: Interview Guide for Key Informant Interview

1) What is the effect, sustainability and possible outcome of shamba systems at Mt. Kenya forest within Kibirichia location in Buuri sub county, Meru County?
2) What are the options for the world's forest landscapes is of Mt. Kenya forest within Kibirichia location in Buuri sub county, Meru County?
3) What do we want our forest landscapes to look like in the coming decades?
4) What goods and services do we want them to provide to Mt. Kenya forest within Kibirichia location in Buuri sub county, Meru County?
5) What is the effects of land size on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?
6) What is the effects of Social economic factors on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?
7) What is the effects of payment of fees on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?
8) What is the effects of capacity-building on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?
9) What is the effects of stakeholder engagement on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

10) What is the effects of distance to the forest on the adoption of PELIS by farmers in degraded forest areas of Marania (Kibirichia) in Mount-Kenya forest, Meru County, Kenya?

Appendix D: Photographs showing the PELIS System

Trees (Cypress) and potatoes planted together in a PELIS system

A PELIS system planted with trees and potatoes in the study area

Young tress growing with crops

Appendix E: letter of Introduction from ANU

AFRICA NAZARENE
UNIVERSITY

12th June, 2018

RE: TO WHOM IT MAY CONCERN

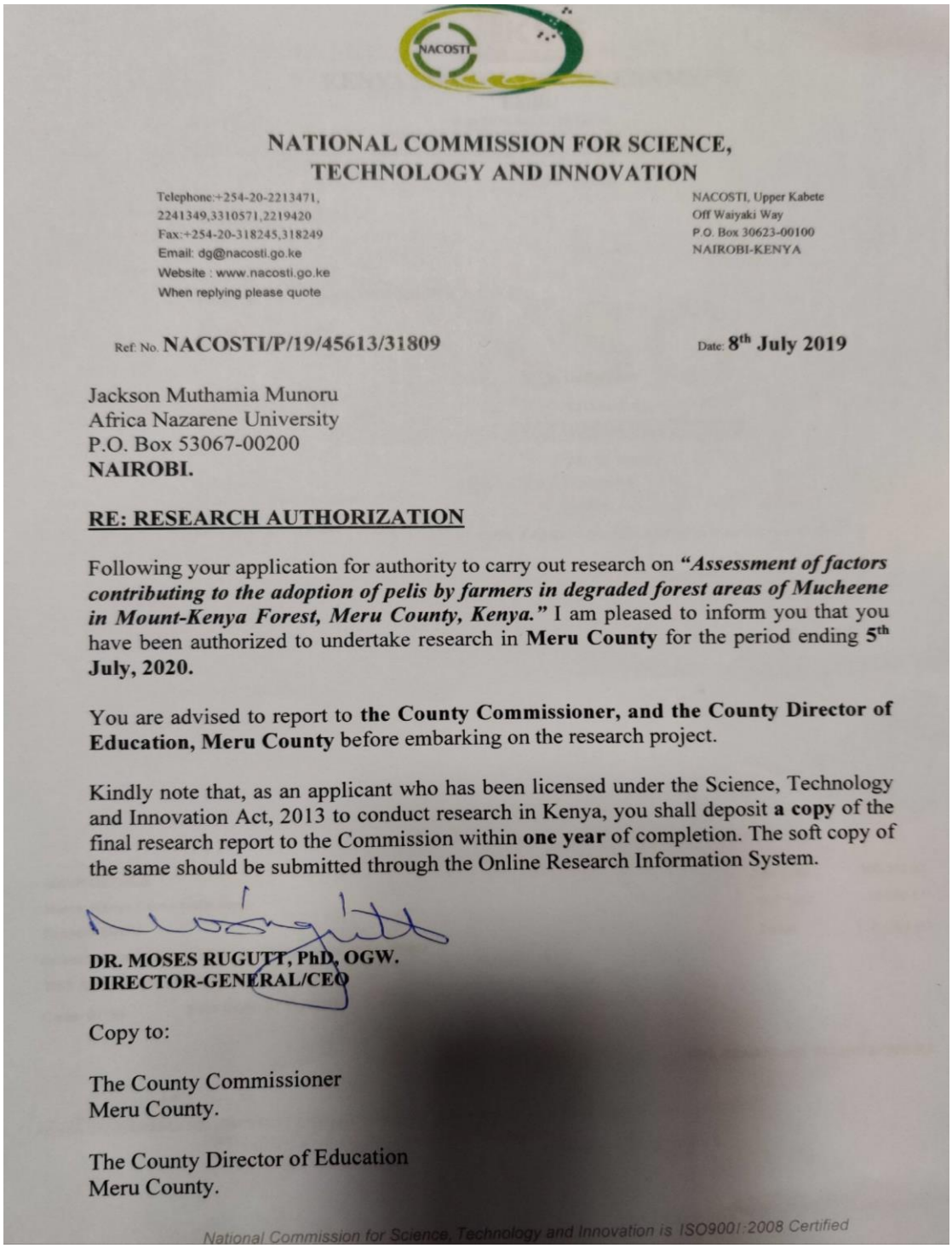
Muthamia Jackson Munoru 16SO1DMEV002 is a bonafide student at Africa Nazarene University. He/She has finished his/her course work and has defended his/her thesis proposal ***entitled "Assessment of factors contributing to the adoption of PELIS by farmers in degraded forest areas of Muchene in mount Kenya forest, Meru county Kenya***

Any assistance accorded to him/her to facilitate data collection and finish his/her thesis is highly welcomed.

Prof. Rodney Reed
Deputy Vice Chancellor, Academic Affairs

P.O Box 53067 - 00200 Nairobi, Kenya ● Tel: 020 252 7170/1 - 5 ● Fax: 020 201 2233 ● Cell: 0733 874 111 ● Email: registrar@anu.ac.ke ● www.anu.ac.k

Appendix F: Research Permit for NACOSTI



NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/19/45613/31809**

Date: **8th July 2019**

Jackson Muthamia Munoru
Africa Nazarene University
P.O. Box 53067-00200
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Assessment of factors contributing to the adoption of pelis by farmers in degraded forest areas of Mucheene in Mount-Kenya Forest, Meru County, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Meru County** for the period ending **5th July, 2020.**

You are advised to report to **the County Commissioner, and the County Director of Education, Meru County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

DR. MOSES RUGUTT, PhD, OGW.
DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Meru County.

The County Director of Education
Meru County.

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified