SOCIAL DETERMINANTS OF ADOPTION OF ON-FARM TREE PLANTING AND ITS CONTRIBUTION TO HOUSEHOLD INCOME IN SHINYALU, KAKAMEGA, KENYA

BY

THALMA KHALWALE LUVONI

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN SOCIAL DEVELOPMENT AND MANAGEMENT

SCHOOL OF ARTS AND SOCIAL SCIENCES

MASENO UNIVERSITY

DECLARATION

Declaration by the Candidate

This project report entitled: *Social determinants of adoption of on-farm tree planting and its contribution to household income in Shinyalu, Kakamega, Kenya* is my original work and has not been presented for a degree in any university. No part of this project report may be reproduced without the prior permission of the author and/or Maseno University.

..... Date: .....

THALMA KHALWALE LUVONI

MA/FA/6026/2013

Declaration by the Supervisor

I confirm that the work reported in this project report was carried out by the candidate under my supervision as a university supervisor.

…….

Date:……

Dr. Abuom, P.O. (Ph.D.)

Department of Environmental Science

Maseno University

ACKNOWLEDGEMENT

I would like to first of all thank the Almighty Father for seeing me through my Master's degree. It has been an uphill task but through his mercies, I have been able to finally successfully complete it.

I express my sincere gratitude to my supervisor Dr. Paul Abuom for his patience, advice, useful comments, critique and support towards accomplishing this work. I also appreciate the assistance of other lecturers in the Department of Sociology and Anthropology who taught me various units that led to the accomplishment of my research work. I greatly appreciate the former Director of KEFRI, Dr. Ben Chikamai for facilitating my field work and giving me the opportunity to balance my work and studies.

Lastly, I would like to whole heartedly appreciate my family for everything they have done for me. I thank my dear husband Dr. Andrew Luvoni for paying my school fees and ensuring I never lacked during and after my studies. May God always favor and keep blessing him abundantly. I thank my late father, Gaeb Ashiono Khalwale for believing in me and encouraging me to enroll for Masters and progress in my studies. I would like him to know that I finally made it! I thank my mother, Frida Musabi for the moral support, prayers and faith that I would successfully accomplish my Masters. I thank my brothers Marvin Mavya Ashiono and Yul Brian Khalwale for standing by me, encouraging me and showing me endless love. Finally, I would like to thank my three lovely children, Tatyana, Tyrone and Tyra for inspiring me to forge ahead in my studies and be a good role model to them. May they achieve greater heights than I would have ever imagined.

DEDICATION

I dedicate this work to my dear husband Dr. Andrew Luvoni who saw me through my Masters, my children, Tatyana, Tyrone and Tyra for whom I struggle to be the best role model, and, my dear parents the late Gaeb Ashiono Khalwale and Frida Musabi who taught me the value of hard work and supported me to be the best I could ever be. I appreciate their upbringing that saw me grow into a morally upright person, their wise counsel and constant reminder that I could be anything that I wanted to be in life.

May God bless you Mum, Andrew, Tatyana, Tyrone and Tyra!
To Dad, keep Resting in Peace. You were the best!!!

ABSTRACT

Throughout the world, deforestation continues at an alarming rate of about 13 million hectares a year. Human activities are by far the most common and most destructive cause of deforestation in Africa and other tropical regions as most rural people depend on forests for livelihood and income. The Kenyan government has promoted on-farm tree planting as an intervention to ease community dependence on forest resources for livelihood and income. However, this initiative has not been fully embraced by local communities. This study sought to determine the adoption level of on-farm tree planting as a strategy for afforestation and its contribution to household income in Shinyalu Sub-County. The specific objectives of the study were; to assess the extent to which on-farm tree planting has been adopted, to determine social factors influencing adoption of on-farm tree planting, and to assess the contribution of on-farm tree planting to household income vis-à-vis other farming practices. The study was guided by the Theory of Planned Behaviour (TPB) by Ajzen (1991). The TPB explains how attitude towards a behavior influences the choice of adoption of a particular on-farm tree planting pattern and configuration. It also explains how perceived behavioral control determines the factors that facilitate or constrain adoption of on-farm tree planting and the contribution of the practice to household income. The study adopted a cross-sectional study design. Mugenda and Mugenda's (1999) formula was used to obtain a sample of 384 respondents selected using simple random sampling from a population of 13,411. Purposive sampling was used to identify 10 key informants. Primary data was collected using semi-structured interviews, Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). Quantitative data was analyzed descriptively and presented using frequencies and percentages while qualitative data from FGDs and KIIs was organized into emergent themes to establish patterns, trends and relationships. The results of the study showed the extent of adoption of on-farm tree planning was low. Farmers had planted woodlots (24%), trees on boundaries (23%) and scattered trees (21%) as the major patterns and configurations of tree planting. The main social factors that influenced adoption of on-farm tree planting were; distance from the home to the forest (94.0%), gender (72.7), land size (71.4%), education level (68.2%) and family size (63.5%). On-farm tree planting contributed a mean annual income of Kshs 105,616.55 per household and it was the second highest income earner after crop farming in Shinyalu Sub-county. The study recommends that sensitization and training of farmers be done on the importance of on-farm tree planting, propagation of seedlings, and nursery management practices for sustained production. This study provides valuable information on adoption of on-farm tree planting as a conservation and management strategy of forest ecosystems as well as an alternative livelihood source for forest adjacent communities in Kenya.

TABLE OF CONTENTS

DECLARATION ii

ACKNOWLEDGEMENT iii

DEDICATION iv

ABSTRACT v

TABLE OF CONTENTS vi

LIST OF ABBREVIATIONS AND ACRONYMS ix

LIST OF TABLES x

LIST OF FIGURES xi

CHAPTER ONE: INTRODUCTION 1

1.1 Background to the study 1

1.2 Statement of the problem 5

1.3 Research Questions 6

1.4 Overall objective 6

1.5 Specific objectives 6

1.6. Justification of the study 6

1.7 Scope of the study 7

CHAPTER TWO: LITERATURE REVIEW 8

2.1 Introduction 8

2.2 Extent of on-farm tree planting adoption 8

2.3 Social factors influencing farmers' adoption of on-farm tree planting 13

2.4 Contribution of on-farm tree planting to households' income 15

2.5 Theoretical framework 20

CHAPTER THREE: RESEARCH METHODOLOGY 22

3.1 Introduction 22

3.2 Study design 22

3.3 Study area....22
3.3.1 Livelihoods....23
3.3.2 Climate and soils....23
3.4 Study population....24
3.4.1 Sampling procedure and sample size....24
3.5 Data collected....27
3.5.1 Primary data collected....28
3.5.2 Secondary data collected....29
3.6 Data analysis and presentation....29
3.7 Validity and Reliability....29
3.8 Ethical Considerations....29
CHAPTER FOUR: RESULTS AND DISCUSSIONS....31
4.1 Introduction....31
4.2 Extent to which on-farming tree planting has been adopted....31
4.2.1 Patterns and configurations of tree planting....31
4.2.2 Reasons for preference of patterns and configurations....33
4.2.3 Types of tree species planted on farm....36
4.2.4 The survival rate of tree seedlings planted on-farm....39
4.3 Social factors influencing adoption of on-farm tree planting....41
4.3.1 Age of the household head....42
4.3.2 Family size of the household....42
4.3.3 Effect of Farm and off- farm income on adoption of on-farm tree planting....44
4.3.4 Gender roles in tree establishment and management....44
4.3.5 Access to credit facilities by the household head....47
4.3.6 Education Level of the household head....48
4.3.7 Land size of the household head and on-farm tree planting adoption....50

4.3.8 Distance from the household to the forest and trees planted 53

4.4 Contribution of on-farm tree planting to households' income……...56

4.4.1 Reason for preference of other farming practices apart from on-farm tree planting.....56

4.4.2 Contribution of farming practices to household income.....59

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.....65

5.1 Summary of findings.....65

5.1.1 Extent to which on-farm tree planting has been adopted.....65

5.1.2 Social factors influencing adoption of on-farm tree planting 66

5.1.3 Contribution of on-farm tree planting to household income vis-a-vis other farming.....66

5.2 Conclusions.....67

5.3 Recommendations.....68

5.4 Areas for further research 69

REFERENCES.....70

APPENDICES.....98

LIST OF ABBREVIATIONS AND ACRONYMS

ACC	African Conservation Centre
ACTS	African Centre for Technology Studies
CFA	Community Forest Association
ECA	Economic Commission for Africa
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GNP	Gross National Product
GZDSP	Green Zones Development Support Project
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
KNBS	Kenya National Bureau of Statistics
MEA	Multilateral Environmental Agreements
MENR	Ministry of Environment and Natural Resources
MEF	Ministry of Environment and Forestry
MUERC	Maseno University Ethical Review Committee
NEPAD	New Partnership for African Development
SDGs	Sustainable Development Goals
SEI	Stockholm Environmental Institute
TAFDA	Teagasc Agriculture and Food Development Authority
TPB	Theory of Planned Behaviour
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change

LIST OF TABLES

Table 1: No. of sampled households in each location 25

Table 2: Sampling of households..... 26

Table 3: Reasons for preference of patterns and configurations..... 33

Table 4: Tree species and the number of trees planted..... 36

Table 5: Survival rate of planted seedlings..... 40

Table 6: Social Factors influencing adoption of on-farm tree planting..... 41

Table 7: Family size of the household and number of trees planted 43

Table 8: Effect of farm and off-farm income..... 44

Table 9: Allocation of gender roles in tree establishment management..... 45

Table 10: Level of education and the mean number of trees planted..... 48

Table 11: Land size and mean number of trees planted..... 50

Table 12: Type of land ownership and mean acreage owned..... 52

Table 13: Land use system and mean acreage allocated..... 50

Table 14: Trees planted and distance to the forest..... 52

Table 15: Distance to the forest and forest products obtained..... 52

Table 16: Reason for preference of other farming practices..... 54

Table 17: Income from various farming practices..... 60

LIST OF FIGURES

Figure 1: Patterns and configurations of tree planting…….31
Figure 2: Access to credit facilities……..47

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Forests cover about 25% of the world's land mass and are critical in provisioning of various commodities and services such as water, food, medicine, fuel wood, fodder and timber (Landell-Mills and Porras, 2002). However, there is unprecedented increase in deforestation globally. The Food and Agriculture Organization (FAO) notes that about 13 million hectares of the world's forests are cut down and converted to other land uses every year (FAO, 2006). For instance, in the period 1990 to 2000, the world lost about 3% of its forest cover to alternative land uses (UNEP, FAO and UNFF, 2009). This raises serious concerns about the sustainability of the various services provided by forests and the need to seek alternative sources for such services. There is a great global attempt to plant and restore forest land but paradoxically tree cover is still being lost (Blunt, 2018). Although the rate of global deforestation slowed by more than half in the past 25 years, tree loss increased to 50% in 2016 and worsened in 2017 (Blunt, 2018). This tree loss can be reduced if local communities adopt on-farm tree planting.

On-farm tree planting is the practice of growing trees on privately owned agricultural land, wasteland, and degraded forests. It has been described by the World Bank as "the least costly and economically the most effective approach to afforestation of rural areas" (World Bank, 2008). It has become a subject for systematic study and improvement, and a livelihood option promoted by land use managers and international development efforts (Zomer, 2014). It is an area of interest to global analysts and policy makers, for example UNFCCC (2008) and MEA (Hassan et al., 2005). It has been recognized in regional and national development plans (NEPAD, 2003) and is an obvious component of many farming systems. Adoption of this practice will aid in reducing forest degradation and provide a source of livelihood for local communities.

Globally, the amount of tree cover on farm land increased substantially in percentage in the last two decades (Zomer, 2014). South America had the largest increase in area with more than 10% tree cover; an increase of 12.6%. South Asia had a large increase as well (6.7%),

East Asia (5%), Oceania (3.2%) and Southeast Asia (2.7%). In Central America, the area with more than 10% tree cover increased by 1.6% to 96% of all farm land. Sub-Saharan Africa had an increase of 2%. Only Northern and Central Asia showed a decrease (2.9%) (Zomer, 2014). Despite the increase in tree cover on farm land throughout the world, Africa is still lagging behind. There's therefore need for studies to determine the extent to which adoption of on-farm tree planting has been embraced in Africa.

On-farm tree planting has been adopted in Pakistan where 781,000ha of land have been put under it. This is because it has been identified as a feasible solution to the low proportion of forestland and continuous degradation of existing forest cover (Nawaz, 2016). It is valued by farmers due to its economic benefits and the fact that it is environmentally friendly. It is a success because farmers have acknowledged and addressed the factors that determine whether or not trees will be planted. Zubair (2002) argues that, the decision of a farmer to plant or not to plant trees on his farm in Pakistan is highly influenced by social referents. Farmers living in rural areas of Pakistan discuss issues relating to on-farm tree planting with their friends and fellow farmers and this highly influences the decisions they make. The social context is different in every society, there's therefore need for more studies to find out how the scenario is in other areas.

Studies by Vidal (2018) show that in India, nearly 15,000 acres have been revitalized by the Araku project which has seen local communities plant millions of fruit trees on their farms. The fruit trees have supplemented the available sources of food in households hence ensuring food security. These studies show that on-farm tree planting is a very important initiative that can be used to improve the socio-economic and environmental conditions of rural households. It has been proven to not only put food on the table, but also create jobs and control climate change (Vidal, 2018). However, the study did not look at how much on-farm tree planting contributes to household incomes. There's therefore need for more studies to further determine the contribution of on-farm tree planting to household income in comparison to other farming practices to ascertain whether it may be a beneficial practice to farmers.

In Africa, despite the importance of forests in socio-economic and sustainable development, the forest estate is declining at a faster rate due to increasing deforestation, land degradation and poor forest management practices. From 2000 to 2010, Africa recorded an annual loss of about 3.4million hectares making it second largest net forest loser in the world (ECA, 2012).

In countries like Ethiopia, Malawi, Nigeria, Tanzania, and Uganda, social factors such as gender, land, labor endowments, forest proximity and national context are the key determinants of adoption of on-farm tree planting (World Bank, 2016). In Rwanda on the other hand, on-farm tree planting has been driven by socio-economic factors such as the need for food, firewood, poles and a source of income. This means, policy measures that target food security and income diversification in rural areas enhance on-farm tree planting (Ndayambaje, 2012). A study done in Uganda by Nambiro (2007) found that, an understanding of land use trends, agricultural intensification and the driving forces of farmers is required to target technology options for on-farm tree planting. Contrary to this, according to Kakuru, Doreen and Wilson, (2014), in their study done in Kibaale District, Western Uganda, a farmer's decision to adopt on-farm tree planting is influenced by household and field characteristics. The factors that significantly influenced the decision to adopt on-farm tree planting were: gender, tree tenure security, availability of seed and supply, guidance by extension and research institutions, size of landholding per household, fuel wood scarcity, and main source of household income. Evidently, the factors that influence adoption of on-farm tree planting varies from country to country thus making generalizations may not be possible. In Mali and Ethiopia, farmers are now planting, protecting and managing many more trees on their farms in order to tackle land degradation and food security (World Agroforestry Centre, 2017). Vidal (2018) adds that, the Seno plains of Mali are unrecognizable from 30 years ago and in the Tigray region of Ethiopia, nearly 1M hectares of unused land have been re-greened and transformed. Crop yields are increasing, and fewer young people are leaving their villages.

On-farm tree planting initiatives in Kenya have mainly been premised on the Forest Act 2005, which specifies the need for adoption of on-farm tree planting as a way of increasing low forest cover, diversifying subsistence products and income, while contributing to soil and water conservation (GOK, 2007). Kenya's forest cover is estimated to be about 7.4% of the total land area, which is far below the recommended global minimum of 10% (Ministry of Environment & Forestry, 2018). In recent years, Kenya's forests have been depleted at an alarming rate of about 5,000 hectares per annum (Ministry of Environment & Forestry, 2018). The depletion has the potential to hinder the attainment of Vision 2030 and the Government's Big Four Agenda of food and nutritional security, affordable and decent housing, universal healthcare and manufacturing, if it is not urgently addressed. There has been excessive exploitation of highly sensitive forest resources by local communities, leading

to a reduction in biodiversity, pressure on water resources, and increased wildlife-human conflict. The revised policy framework for forest conservation (2014) encourages the establishment of national programmes to support community forest management and on-farm tree planting on community and private land (GOK, 2007). Despite the existence of such an initiative, there is a dearth of knowledge on the extent of on-farm tree planting in local communities, yet this information is critical in designing appropriate adoption strategies.

In Kenya, adoption of on-farm tree planting contributes greatly to household income and environmental benefits. It increases the assets of poor households by providing readily available farm grown trees that can be used as a source of fuel wood, food, and sold to earn a source of income. It enhances livestock productivity and soil fertility on farms thereby increasing both milk production and food crop yields. This improves socio-economic status of households, eliminates poverty and improves their living standards (Garity and Stapleton, 2011). Although, it is known that trees on farms support households, there is little quantitative data on the contribution of on-farm tree planting income to household welfare. Most of the information on contribution of on-farm tree planting to households is descriptive, and often location specific (MENR, 1994). The net effect is poor understanding of the role of on-farm tree planting in local livelihoods which this study intends to fill.

Shinyalu Sub-County is an agricultural area and maize production is the main occupation of most households (BIOTA, 2010). It has a population of 118,049 (KNBS, 2009). This high population has led to subdivision of land into smaller units for intensified maize cultivation. As a result, grazing areas have shrunk and dairy production is slowly collapsing denying farmers a key alternative source of income. Due to the high reliance on trees for firewood, fodder, timber and herbs, farmers have resorted to obtaining tree products from the nearby Kakamega forest instead of planting them on their farms. This has led to severe degradation of this forest. As a result, the tree cover in Shinyalu stands at 1.7% (BIOTA, 2010), as opposed to the country's 7.4% which is against the requisite 10% as per world standards (MEF, 2018). Though farmers have been sensitized by various organizations such as KEFRI on the importance of planting trees to conserve the forest and increase their household income, they still exhibit slow adoption rates (KEFRI, 2015). However, available literature does not show the extent of adoption of on-farm tree planting in the area. Studies by Zomer et al (2009) have found that, despite the apparent ubiquity and importance, it has been hard to find reliable data on the actual extent of on-farm tree planting. This lack of data, and more misconceptions of what on-farm tree planting is, has led to the assumption that it is of little

importance. Zomer (2009) further asserts that the removal of trees from landscapes has for long been seen as a sign of intensification and progress, especially where mechanization of agriculture was involved. Tree cover on agricultural lands thus has had to catch up with misperceptions and lack of recognition, similar to the 'trees outside forests' that have been defined by the Food and Agriculture Organization of the United Nations (De Foresta et al., 2013) as complements of trees inside forests. Such misunderstandings lead to suboptimal policy decisions and the best way to reverse them is by providing objective, data-based measures of the extent of on-farm tree planting adoption through conducting studies on the same. This study therefore sought to determine the adoption level of on-farm tree planting as a strategy for afforestation and its contribution to household income in Shinyalu Sub-County.

1.2 Statement of the problem

The natural forest in Shinyalu Sub-county has declined primarily due to anthropogenic activities. Central to the anthropogenic activities is the dependence of the people on forest products and services for livelihoods. These human perturbations have threatened biodiversity and future ecosystems functions of this forest and thus livelihoods. On-farm tree planting has been advocated by the Kenyan government as the most reliable way of protecting the forest and sustaining socioeconomic development of rural communities. Despite the fact that community members have been sensitized on the need to plant trees on their farms and protect the forest, the natural forest continues to face severe degradation. The efforts towards reducing this degradation are informed by effective adoption of on-farm tree planting. It is acknowledged that determining the extent to which on-farm tree planting has been adopted could enhance effectiveness of the practice. Secondly, the social factors that influence on-farm tree planting adoption among smallholders within farming communities in the study area are not known. The available information is scanty and contestable since the social factors vary depending on the location and the kind of tree products used. Moreover, although on-farm tree planting is important to local livelihoods, there is hardly quantitative data on the contribution of on-farm tree planting to household incomes. The existing literature only focuses on crop farming as the major source of income ignoring other farming practices. This study thus determined the social determinants of adoption of on-farm tree planting and its contribution to household income in Shinyalu Sub-county.

1.3 Research Questions

What is the extent of on-farm tree planting adoption in Shinyalu?
What are the social factors that influence adoption of on-farm tree planting in Shinyalu?
What is the contribution of on-farm tree planting to households' income vis-a-vis other farming practices in Shinyalu?

1.4 Overall objective

To assess the social determinants that have influenced adoption of on-farm tree planting as a livelihood and income source in Shinyalu.

1.5 Specific objectives

To assess the extent to which on-farm tree planting has been adopted in Shinyalu.
To determine social factors influencing adoption of on-farm tree planting in Shinyalu.
To assess the contribution of on-farm tree planting to household income vis-a-vis other farming practices in Shinyalu.

1.6. Justification of the study

Shinyalu Sub-County was chosen for this study due to the community's over dependence on the nearby Kakamega forest. This has been caused by subdivisions on their small farms for crop production. As a result it has become a challenge for farmers to plant trees on their farms because of the competing land uses. They have resorted to the forest to obtain forest products and this has led to severe degradation of this forest. The Forest Policy (2014) provides a framework for improved forest governance, resource allocation, partnerships and collaboration with the state and non-state actors to enable the sector contribute in meeting the country's growth and poverty alleviation goals within a sustainable environment. However, formulating a policy is insufficient, on its own to bring about the envisaged forestry reforms. There is a need for commitment from all citizens to ensure that reforms are implemented and the necessary institutional changes achieved successfully. The National and County governments have to play their part in providing an enabling environment, effective extension service, forestry research and allocation of funds to the sector. Meaningful participation of stakeholders will continue to be sought through regular consultation and

discussions, as the most efficient, sustainable and equitable use of forest resources is strived to be attained.

1.7 Scope of the study

For purposes of this study, the focus was on Shinyalu Sub-county, Kakamega County. It was undertaken in 2 locations; Shibuye and Muranda, covering households both close to the forest and those that were far. The study focused on determining the extent to which adoption of on-farm tree planting had been done within the last 5 years. This is because it takes an average of 5years for a tree to grow to a reasonable height of about 15feet once it has been planted, and count as a tree that will survive to maturity. At this age the owner can also start benefitting from its products. The study also determined the factors that influence adoption of on-farm tree planting such as land size, size of the family household and education. It also assessed the contribution of on-farm tree planting to household income in comparison to what other farming practices contribute to the household that makes them either be preferred or not.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a critical review of findings of some of the previous studies with a view to contextualize the research problem for this study. In so doing, this chapter presents comparisons and contrasts of literature on the extent of on-farm tree planting, the factors influencing adoption of on-farm tree planting and, the contribution of on-farm tree planting to household income vis-a vis other farming practices. It also presents a theoretical literature review explaining Ajzen's theory of planned behavior and measurable indicators of adoption of on-farm tree planting.

2.2 Extent of on-farm tree planting adoption

On-farm tree planting, has been a traditional land use developed by subsistence farmers throughout the world. In the last 40 years, it has also become a subject for systematic study and improvement, and a livelihood option promoted by land use managers and international development efforts. It has come to the attention of global analysts and policy makers, for example UNFCCC (2008) and MEA (Hassan et al., 2005), and has been recognized in regional and national development plans (NEPAD, 2003) and is an obvious component of many farming systems (World Agroforestry Centre, 2009). Developing countries are facing major challenges to their rural land use, including deforestation, increasing scarcity of tree products, and environmental degradation on fragile agricultural lands. One of the ways they have responded to these problems is by promoting on-farm tree establishment and management.

Some studies have assessed the extent of on-farm tree planting in different areas. For instance, GOK Sessional Paper No.1 on Forest Policy states that, tree cover on farms is increasing, especially in high potential areas with high populations. It can be argued that since these findings were revealed, rural communities and individual farmers' basic skills and willingness to improve their land management practices through on-farm tree planting for their own benefit may have increased. Githiomi et al (2012) on the other hand found that rural communities in Kenya have had a few successful tree planting programs led by government rural forest extension services and various non-governmental organizations. The

study found that the decision by farmers to plant trees becomes difficult due to many land use needs especially agriculture in enhancing food security. The situation at present is similar to the findings of this study.

According to Kuria (2013), the extent of on-farm tree planting adoption can be determined by the various patterns and configurations that have been used to plant trees on the farm. These include alley cropping, contour planting, fodder banks, woodlots, boundary, improved fallows, fruit orchards, scattered trees on farms and medicinal trees. Kuria (2013) found that tree farmers in Mbeere District have adopted suitable tree planting patterns and configurations on their farms to meet their requirements in terms of wood based tree products and ensure agricultural sustainability that maximizes on farm productivity and improves their livelihood. This means that the farmers have their own supply of tree products and therefore do not have to depend on natural forests which may lead to their degradation. As a result the extent of adoption of on-farm tree planting in the area is very high.

A study by Chamshama (2011) found that the extent of woodlots and impacts on livelihoods remain little known in Eastern and North Eastern Africa. However, FAO (2009b) in a study done in South Africa showed that woodlots have positive impacts on sustainable livelihoods and environmental Services. They diversify farm production by offering an additional income and employment possibilities for local communities. The viability and attractiveness of this pattern and configuration is demonstrated by the increased involvement of private land owners and communities in South Africa and the rapid rate of increase of growers on their farms. This means that the extent of tree planting on-farms is very high. A study by Dewees (1993) however had a different opinion, it showed that in Kenya, woodlots are more likely to be adopted as households age, family labour becomes scarce, and as there are fewer needs for income from more capital and labour intensive cash crops. Tree planting is seen as a means of keeping land under a productive fallow crop.

Other studies by Prevedello et al. (2017) found that scattered trees within a fragmented landscape have a significant role to play in combating the effects of habitat loss and fragmentation. Fischer and Lindenmayer, (2008); Gibbons et al. (2008) had similar findings that showed landscapes with scattered trees supported greater levels of biodiversity than landscapes without scattered trees, reinforcing the idea that scattered trees are 'keystone' structures of landscapes. Bailey (2007) reported that hedgerows and scattered trees alongside roads and railway lines are often cited as examples of habitat corridors. This indicates that

scattered trees can indeed be regarded as patterns and configurations that signify high adoption rates of tree planting on farms as their presence denotes increased environmental conservation.

In San Juan de Limay, Nicaragua, Taking Root (2013), an NGO, described trees on boundary as living fences or barrier planting because it involves planting trees along any kind of boundaries. These include edges of property, agricultural fields, pastures, roads or any other place where fences might be located. The NGO recognizes the importance of building a harmonious and sustainable relationship between the farmers and their natural environment. It has therefore trained them on the proper ways of planting trees and they have as a result planted long lines of trees. It adds that this method of tree planting allows natural regeneration to take place and, over time, forests in the area increase in structural and ecological diversity. Contrary to this, a study done by Dewees (1995), found that the rationale for trees on boundaries is not so clearly related to the potential for income generation or for alleviating household labour constraints, or to other household resource allocation strategies. It yields few immediate financial or economic benefits. The economic benefits to the household from these kinds of planting are very minor, such as provision of fodder and fuel production. Consequently, the adoption of this pattern and configuration cannot be understood solely in terms of its immediate or potential financial or economic benefit to the household.

Studies have been done on the reasons for preference of various patterns and configurations. Dewees (1995), for instance reported that, some tree-growing patterns are closely related to the presence of markets for tree-based products and to heavy household demand for those products. For example, woodlots of Eucalyptus (saligna and grandis) are sometimes planted to meet the growing demand for construction poles. Black wattle woodlots (*Acacia mearnsii*) are common in areas where there are markets for wattle bark for the tanning extract industry, and for charcoal and firewood. Cypress (*Cupressus lusitanica*) is often grown by smallholders and harvested by pit sawyers for sawn timber. Ham (2018) in a study carried out in South Africa found that woodlots are established mainly for environmental reasons, i.e. to stop the degradation of natural woodland which has been subjected to harvesting of poles and firewood. The price of wood from woodlots established in South Africa has been subsidized to make utilization of timber from them more attractive than utilization of indigenous vegetation.

Previous studies have shown that scattered trees have many important ecological functions such as offering shelter and fodder sources for animals, enhancing landscape connectivity by acting as stepping stones, and functioning as nuclei for plant regeneration in disturbed landscapes. They also enhance the provision of ecosystem services that might benefit farmers and owners of rural properties, such as pollination of crops, shading for cattle, and firewood provision (Fischer & Lindenmayer, 2007). These explain the reason why a farmer may prefer planting scattered trees on his farm over other patterns and configurations. The findings of Harvey and Haber (1999) agree with the above that scattered trees provide a range of ecosystem services such as shade for livestock, shade tolerant crops, a buffer against soil acidity, soil erosion control and desertification, and, are a cheap source of tree seed.

In a study carried out in Nicaragua, Taking root (2013) argued that trees on boundaries are meant to provide both economic and ecological benefits in short, medium, and long terms. A farmer will therefore prefer this pattern of tree planting because in the short term, the fast-growing trees will release nitrogen into the soil and prevent soil erosion, increasing the quality of the cattle pasture. The small branches and leaves on the other hand will provide a good source of fodder for cattle, which has been shown to raise milk production. In the medium term, the farmers will get valuable sources of timber and fuel-wood, and this discourages them from cutting down other forests to meet their needs. Farmers can also sell them locally and earn an additional income. In the long term, the farmer will get seeds, fruit and a habitat for local flora and fauna. The trees will also produce highly valued timber, which can be sustainably harvested by the farmers and sold. Tengnas (1994) found that boundary planting reduces wind speed, and there is no need to establish windbreaks. Trees on boundaries which are regularly pollarded can meet most of a family's need for firewood. In addition, other products and services are obtained and the boundary is effectively demarcated. However, if the trees are not well managed there may be negative effects on crops, and if competitive species are planted root competition may be a problem. Conflicts with neighbours may also arise if the sharing arrangements are not well handled.

The extent of on-farm tree planting adoption can also be determined by the types of tree species planted. This is because a farmer’s regard for a specific tree species will determine his need to plant more of that particular tree. This will lead to high levels of adoption of on-farm tree planting. A study done in Tarakwa by Rotich (2017) revealed that farmers in the area planted both exotic and indigenous tree species with the five most preferred tree species being *Eucalyptus grandis* (86%), *Cupressus lusitanica* (80%), *Grevillea robusta* (78%),

Pinus patula (62%), and *Acacia mearnsii* (40%). On-farm tree planting was practiced for commercial purposes; (timber, electricity transmission poles, charcoal) domestic use; (timber, fuelwood, medicinal herbs, fodder) and ecological benefits (soil conservation, soil fertility improvement). The preferred species were therefore selected for their high economic value. Other studies have found that the choice of tree species to plant usually varies with individual farmer's tree knowledge, interest and land size. It may also depend on other factors such as species compatibility with crops, duration to harvesting and the value of end products (Simons et. al., 2000; Lengkeek et. al., 2005). Carsan (2006) concludes that, overall, trees on farm are appreciated for their role in meeting domestic wood requirements, provision of income and enhancing soil biophysical conditions. Indigenous timber species such as *Cordia africana, Milicia excelsa, Newtonia buchananii* and *Vitex keniensis* are further appreciated for their soil improvement roles amongst other functions such as water catchment protection and certain cultural values.

Other studies by Bradley and Kuyper (1985) found that, in most Kenyan farms, although planted tree species are predominantly introduced varieties, such as *Grevillea robusta, Eucalyptus sp*. or *Acacia mearnsii*, a number of indigenous species such as *Markhamia sp*., *Croton sp.*, and *Sesbania sesban* also feature in farmers' range of choices. The dominant species vary in each County. In Kakamega County, in Western Kenya, woodlots are almost always dominated by *Eucalvptus saligna* while in Murang'a County in Central Kenya; they are dominated by *Acacia mearnsii*. Trees on boundaries are usually composed of *Cupressus lusitanica***.** They are planted in the first instance, but as they grow to maturity, they may come to include other species established as a result of natural regeneration.

Studies on the survival rate of planted tree seedlings have shown that survival rate highly determines the extent of on-farm tree planting adoption. In a study carried out in Indonesia, Nambiar (2008) asserted that the general low productivity and quality of trees planted by small-scale farmers throughout Indonesia is as a result of various factors which include, unsuitable site-species matching, poor quality seedlings and poor silvicultural management and plantation protection. As a result, there have been doubts on sustainability of trees planted on-farm with such conditions, both in terms of biological productivity, and their potential impact on the environment. Such trees have a very minimal chance of surviving to maturity, and therefore put at risk the chances of increasing the tree cover in the area. Similar results of studies done in the United States by Widney et al. (2016) have shown that in order for trees to continue providing increasing annual benefits during the 10 years of planting, the

annual survival rate of planted seedlings should be higher than 93% during the establishment period. Without early intervention to ensure survival of planted tree seedlings, tree mortality may be significantly undercutting the ability of tree planting programs to provide benefits to communities. A study by Anton (2015) on Survival and growth of planted seedlings of three native tree species in urban forest restoration in Wellington, New Zealand found that most restoration practitioners use native species, mostly planting container-grown seedlings, to facilitate restoration of forest habitats. However, survival rates and the factors influencing mortality are not accounted for in many restoration projects. This leads to drawbacks when seedlings are planted such as seedlings experiencing transplanting shock; that is, the time required for seedlings to acclimatize to their new environment. During acclimatization to site-specific conditions, seedlings experience stress and are vulnerable to unfavorable environmental conditions such as weather extremes and diseases. This potentially results in high mortality. Holzwarth et al. (2013) adds that understanding tree seedling mortality is a complex process which is highly context-dependent and species-specific. Despite the delicate nature of seedlings, Graham and Filmer (2007) assert that mortality of seedlings, generally decreases over time and can become negligible in as little as 2 years after planting. Opportunities therefore exist for implementation of short-term intensive management aimed at improving initial seedling survival without increasing the already substantial direct and indirect costs associated with on-farm tree planting (Douglas et al., 2007).

2.3 Social factors influencing farmers' adoption of on-farm tree planting

Several studies done in the tropics have analyzed the socioeconomic and perceptional factors that influence farmers' decisions to plant trees on their farms. Hyman (1983) and Byron (2001) found that farmers who plant trees on-farm generally have the following characteristics: high enough income, necessary material and technology, enough land with secure land and resource tenure. Salam et al. (2000), Simmons et al. (2002) and Summers (2004), added enough land with secure land and resource tenure. The findings of Arnold and Dewees (1997), Ravindran and Thomas (2000), showed that limited labor but enough for tree planting was necessary. Byron (2001) asserted suitable skills and knowledge were some of the most important factors. According to (Sen and Das 1988; Mahapatra and Mitchell 2001) interaction with other farmers; such as farmers' groups was also important. Much as these factors go across the board, the specific factors that determine adoption of on-farm tree

planting in Shinyalu Sub-county need to be established. This is because there could be certain pertinent factors that are more critical in this area.

Other studies have argued that environmental or biophysical factors can affect the farmers' planting and management activity. These include site quality (Kumar, 2003; Jagger et al., 2005), access to markets (Ravindran and Thomas, 2000; Arnold, 2001; Scherr, 2004), the physical location of the land, or the farmers' living location (Dewees and Saxena, 1997). If targeted well, external actors that promote tree planting and provide incentives can be an efficient way to encourage the farmers to plant trees (Carnea, 1992; Salam et al., 2000; Simmons et al., 2002; Enters et al., 2004).

According to Masangano (1996) and Omoregbee (1998), some of the farmers' characteristics that may influence adoption of on-farm tree planting technologies include age of the household head, education level of family head, gender, wealth, family size, group membership, farm size, land size, credit and labour availability. The adoption behavior of farmers especially in low-income countries is influenced by a complex set of socio-economic, demographic, technical, institutional and bio-physical factors. Similar studies by KEFRI (2008) have indicated that land size for instance, for on-farm tree planting has continued to shrink because of high land fragmentation and settlement, unsupportive land tenure arrangements whereby women, married sons and other landless have limited access to land for either tree planting or management of naturally growing woodlands. In Mbeere, Kuria (2013) found that a farmers' ability to expand on-farm tree planting to meet their tree requirements has been constrained by lack of enough land for expansions as most of them rely on their family lands which can hardly allow massive investment in tree planting. Such a challenge could pose a threat in the efforts to enhance on-farm tree planting.

Even though Bannister and Nair (2003) discovered that the way farmers practice on-farm tree planting changes over time as their experiences increase, the characteristics of their farms change, or their household resources increase or decrease as they age, (Upton, 1996) observed that the objectives, knowledge and attitudes of farmers have an influence on on-farm tree planting. Farmers have multiple objectives for growing trees. They grow them as a source of cash, for their own consumption, animal fodder and other service functions. These objectives are likely to influence the decision-making process. However, studies by Adesina and Chianu (2002) agreed with the results of Bannister and Nair (2003), that the farm

experience and education, both formal and informal training, of the farmer are important characteristics that influence decisions made in on-farm tree planting.

Pannell (1999) had a different opinion, he found that apart from household and field characteristics, the likelihood of farmers planting trees is also dependent on their attitudes and perceptions; i.e. perceptions of feasibility and value of the likelihood that trees will promote the farmers' overall objectives. He also asserted that more importantly is the perceived risk in agricultural production system. Farmers' risk assessment of on-farm tree planting often arises from tenure security and production failures. This shows that farmers might as a result of fear fail to plant trees due to the risk of not getting any profit. According to GOK (2007) the government's major driving force for promoting on-farm tree planting programs is to increase timber and fiber resources, while for the farmers; there is an expectation for additional sources of income. Yet, it is still questionable whether on-farm tree planting for timber or fiber is an economically attractive land-use option for the farmers as it is currently being practiced. Contrary to these findings, a study done in Central Kenya by Dewees (1991) showed that despite the fact that coffee and tea earn very high profits of up to four times more than *Acacia mearnsii*, the tree was still very widely adopted in the area. This means profit from tree products is not such an important factor to farmers.

The success of on-farm tree planting under different arrangements varies, and there are several examples of constraints that farmers in the tropics may face. Such constraints include: unfair or unclear benefit sharing or user rights in cases of company-community partnerships (Nawir and Santoso, 2005), general suitability of on-farm tree planting as a livelihood option (Arnold, 1997), market-related barriers, institutional or policy barriers (Barr et al., 2006), cultural aspects (Hyman, 1983), and environmental or technical aspects (Van Noordwijket al., 2007). For example, Byron (2001) pointed out that smallholder tree planting can only be successful if all the "keys" of successful tree planting are in place (i.e. not constrained by the above mentioned factors).

2.4 Contribution of on-farm tree planting to households' income vis-a-vis other farming practices

Studies by Jacovelli and Caevalho (1999) have shown that on-farm tree planting is now a popular venture among government agencies and research institutions as a means of improving fuel wood supply to rural communities and generating income for households.

This is because, traditional long duration fallows and shifting cultivation, which help to replenish soil fertility to some extent, are no longer possible due to land shortage as a result of high population density. However, Buyinza (2008) disagrees by asserting that, acceptance of such technological agroforestry innovations, depends on a number of social and economic factors extending far beyond the simple cost-benefit calculations. He adds that, land allocation among the different components in the farming system (food crops, cash crops, tree crops, and livestock) is primarily determined by a complex of social, economic, and cultural factors (Buyinza, 2009). Other farming practices in Shinyalu include crop farming, livestock rearing and bee keeping. Being an agricultural community, the inhabitants rely greatly on maize production to sustain their livelihoods. The little available land has been converted into maize farms as this is their major source of income. Livestock rearing for milk production is also practiced. These three farming practices need to be quantified to determine why farmers prefer one over the other thereby leading to slow adoption of on-farm tree planting.

According to Sale (2014), historically, farmers have protected, planted and managed trees on their farms in order to maintain supplies of products no longer available from natural forests. They also plant them to maintain soil productivity or are grown in areas unsuitable for food crops. However, Stoler (1998) found that traditional farming systems involve management of farms for crop production especially in regions of high population density and decreasing availability of crop and lands. With growing population pressure, the proportion of land under crop farming has been increasing. In some cases up to 70% of cultivated land areas are utilized for crop farming. Other studies have equally shown that crop farming is the most preferred farming practice in most areas. A study done in Indonesia among the Javanese, found that food production is the primary function of most farmers and much of what is produced is consumed by the household. The farms contribute a substantial fraction of a household's food needs. It is estimated, for instance that Javanese crop lands provide more than 40% of the total calorific intake of farming communities in some areas (Terra, 1994). Sale (2014) adds that crop farming is a prominent farming practice because of its ability to produce food throughout the year with relatively low labour inputs. Crops with different production cycles and rhythms are combined to provide a year round supply of foods. Any available surplus that can be taken to the market helps provide a source of income between harvests of other agricultural crops and are a safeguard against crop failure. Crop farming

produces sustainable yields in an economically efficient, economically sound and biologically sustainable way.

A study on livestock in West Africa by Club du Sahel (1995) has shown that trends in human population and urbanization in West Africa in the past and what is projected in future points to an increase in the demand for food of animal origin and significant changes in livestock production systems. The demand for milk and meat in particular is expected to grow by 4% annually as the population of the region continues to grow at 3% per year over the next 25 years, at which time the proportion of town-dwellers may be more than 60%. This upsurge in urbanization and subsequent changes in dietary patterns are likely to impact on the emergence of intensive livestock production systems in peri-urban areas. This has been the case exactly 23 years after this study was done. The demand for milk in Kenya for instance has been so high, resulting in exorbitant prices that have made it difficult for people living below the poverty line to afford this essential commodity. Meat on the other hand is equally expensive with only a few people managing to serve it on their dinner tables.

Preference of livestock farming in many instances is determined by the availability of market to sell dairy and beef products (Kamuanga, 1999). A farmer's preference of buying and rearing different breeds will be affected by the current prices in the market. Sellers of livestock on the other hand will determine the prices to sell based on how different breeds are regarded by the market. Multipurpose milk and beef producers will also be interested in the likely market value of animals that might be culled or sold to meet cash needs. In a study carried out in Nigeria, Greene (1995) established that households that are likely to practice livestock farming do not practice cattle keeping as their main activity, i.e. they are mostly involved in other traditional or subsistence systems.

Hilmi (2011) in a study on bee keeping asserts that, in many African countries, bee keeping is a family undertaking where men do harvesting, while women and children tend to honey extraction and processing. This is however not always the case as women, in particular, can successfully use beekeeping as a livelihood enterprise. Bee keeping is preferred because it does not require excessive labour and time to manage; the bees do majority of the work. Women do not have to travel far to tender the enterprise and it can be a ready source of cash in times of need, as bee products can be sold to neighbours or in local markets. This enables women to be part of an economic activity that can provide them with income and an independence that can support them in times of difficulty. It is also a flexible activity, where

there is no need for constant attention, for instance as with livestock and crops, and hence allows women to follow other matters on the farm as well. The advantage of beekeeping is that it does not require land to be owned and/or rented and soil fertility is not an issue to consider. Feeding the bees is also not an issue as they forage on otherwise unused resources: nectar and pollen. In simple terms, beekeeping does not compete for other resources needed by livestock and crops. Bees help increase crop yields by pollination of farmed crops. The inputs required for beekeeping can be sourced and made locally and do not impinge on other farm activities and required investments. Products that derive from a beekeeping enterprise use little or any farm inputs, apart from labour in harvest and processing periods. The above advantages may act as incentives to farmers to make them prefer the practice over other farming practices.

Affognon et al. (2015) agreed with the above findings by asserting that beekeeping is an important farming activity that helps rural communities to raise additional income to improve their livelihoods. It is also a sustainable form of agriculture beneficial to the environment. In a study done by Nightingale and Crane (1983), they noted that the Government of Kenya through the Ministry of Agriculture, and other development agencies at the time, was involved in campaigns of promoting beekeeping as an income source for households in rural arid and semi-arid areas. Kenya produces about 100,000 tonnes of honey per year, which is far less than the country's demand. The shortfall is bridged through imports (Government of Kenya, 2009). Carroll and Kinsella (2013) found that at the farm level, the estimated honey yield is about 20% of the estimated productivity of a beehive at 3.7 kg per hive rather than 18.5kg per hive, hence indicating that Kenya has a high honey production potential. Therefore, given the high market demand and low productivity, beekeeping is a potential income avenue for farmers in Kenya, and hence the need to evaluate challenges and constraints faced in beekeeping that might deter farmers from taking it up.

Others studies on the contribution of farm activities to household income have been done throughout the world. FAO (2014) states that trees have direct and measurable impacts on people's lives. The production and consumption of wood products, non-wood tree products and services meet food, energy, shelter and health needs, as well as generating income. Although the figures for income generated in the sector and the number of people that benefit from this appear to be low, they remain significant, particularly for less developed countries. The benefits derived from the consumption of tree products and services and the numbers of people that receive these benefits are very high. Planting more trees increases forest/tree

capital, which provides numerous goods and services to economically and environmentally vulnerable local communities (Kalame et al., 2010).

Studies carried out by the World Bank (2001) show that almost 1.2 billion people in developing countries use trees on-farm to get food and generate cash. Dei (1992), Mogaka et al. (2001), Nabangao and Gombya-Sembajjwe (2001) agree with these findings by stating that trees and forests in dry sub-Saharan Africa constitute an important source of income, life support, and means of survival for poor people and women particularly during periods of hardship, drought, and famine. Kaimowitz (2003) concurs with these studies by stating that, losing these tree assets can have negative impacts on rural households and can even threaten their survival.

According to Cheboiwo (2012), In Kenya, on-farm tree planting has come up as an important economic engine in the rural agricultural landscapes especially after realization of the profitability of growing Eucalyptus species. Favorable policies that give emphasis to farm forestry through the Economic Recovery Strategy for wealth and employment creation paper (2003) and the Forest Policy 2005 and Forest Act 2005 have been drawn up by the government to promote tree planting on farms. Among the key favorable actions include a proposal to entrench forest products trade liberalization; tax incentives for trees grown on farms reflected in the 2005-2006 budget; leasehold and concessions to private sector in public forests; the creation of out-grower schemes through appropriate funding mechanisms and promotion of value addition in forest products.

GOK (2007) concurs with the above by stating that the forest sector plays important roles in the livelihood of the Kenyan population through provision of invaluable forest related goods and services. The most significant contribution is in the energy supply for domestic and industrial processes, provision of timber for construction and trees for regulation of water flow. It is estimated that 80% of the population use biomass energy while urban development and hydro energy rely heavily on water. Trees will continue to provide essential goods and services such as timber, poles, fuel wood, food, medicines, fodder and other non-wood forest products. Forest resources and forestry development activities also contribute significantly to the national economy by supplying raw materials for industrial use and creating substantial employment opportunities and livelihoods. On-farm tree planting improves soil and water conservation, and soil fertility, which contribute to increased agricultural production. Wealth creation and employment opportunities for improvement of livelihoods are possible, not only

from intensified farm production, but also through the development of forest based industries and promotion of eco-tourism. Intensified tree planting on farms, commercial production of non-wood products and the promotion of out-grower tree schemes could support forest industries and enhance industrialization and employment creation. This will be enhanced by efficient use of raw materials, appropriate production technology and marketing support. Further, intensified tree planting will result in increased demand for seedlings. This demand will be met through individual and private initiatives in seedling production. In turn, this will create employment for youth and women groups.

2.5 Theoretical framework

This study adopted the Theory of Planned Behaviour (TPB) that was proposed by Ajzen (1991). This theory emerged as a major framework for understanding, predicting and changing human social behavior. According to Icek Ajzen, intention is an immediate determinant of behavior and is itself a function of attitude towards the behavior, subjective norm and perceived behavioral control. These determinants follow respectively, from, beliefs about the behavior's likely consequences, about normative expectations of important others, and about the presence of factors that control behavioral performance. The Theory of Planned Behavior assumes that most human behavior is rational: individuals' behavior makes sense to them. Unlike early theories of adoption which suggested that some people were more prone, by reason of personal disposition, to try out new practices. These socio-psychological models help us to explore the rationality that underlies the individual's decision to engage, or not engage in a behavior. Attitude is the degree of favorableness or un-favorableness toward a behavior (Fishbein and Ajzen, 1975).

This theory has been used in previous studies such as farm forestry in Pakistan where it was used in determining an appropriate measurement of direct and indirect constructs and selection of plausible scaling techniques of constructs; attitude, subjective norm, perceived behavioral control and intention that are important in explaining farm level forestry in Pakistan (Zubair et al., 2011). It has also been used to examine farmers' attitudes towards on-farm tree planting in Malawi (Meijer, S. et al., 2015).

This study used the TPB tenet on *attitude towards the behavior* to explain the choice of adoption of a particular on-farm tree planting pattern and configuration. It suggested that an individual decides how to behave depending on the environment and other externalities. The

theory suggests that an individual considers the likely consequences of a behavior, and as a result, his behavior will be guided by the degree to which performance of the behavior is positively or negatively valued. In the study, if a farmer feels planting a woodlot will prevent trees from blocking sunlight reaching his crops, then he will have a positive attitude towards it and this will make him adopt this particular tree planting pattern and configuration. It is his positive attitude towards this particular pattern and configuration that will make him take it up and therefore increase its adoption rate.

It used the tenet on *perceived behavioral control* to identify factors that facilitate or constraint adoption of on-farm tree planting. These factors either gave a farmer a positive or a negative attitude towards adopting on-farm tree planting. The theory shows that an individual's behavior will be determined by the individual's perceived ease or difficulty of performing the particular behavior. It has been shown to be valid in circumstances where an individual does not have full volitional control over the behavior in question (Ajzen, 1991). In the present case, on-farm tree planting behavior is assumed to be under partial volitional control. The problems which farmers feel they cannot overcome may include, for instance, education, knowledge, land size, and household family size: these constitute factors outside their control whose presence or absence may encourage or discourage the performance of the behavior. For instance, a farmer has no control over the size of land he has, if he has to choose between planting trees on the land and allocating it to his sons, due to the perception that sons need to inherit land from their fathers, the farmer's behavior towards adoption of on-farm tree planting will be controlled by the need to give land to his children. This will in turn prevent him from planting trees on the farm and reduce adoption of on-farm tree planting as a result. In a rural society, strong cultural norms and perceived pressure from social referents may also influence the performance of a behavior.

The theory also uses the tenet on *perceived behavioral control* to explain why it has become difficult to quantify the amount of income earned from on-farm tree planting by households in Shinyalu despite the fact that it is the second highest source of household income according to the study. This is because of the perception that has been formed about its importance. This perception makes farmers see on-farm tree planting as a farming practice of little importance and this in turn influences their negative behavior towards it. The TPB provides a theoretical framework that accommodates these elements and offers an in-depth probe into the contribution of the various sets of beliefs outlined above in explaining farmers' perceptions towards planting trees on-farm.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section presents the methods applied in carrying out the study. It starts by describing the study area. This is followed by research design, sampling procedures, data collection methods and tools used. Lastly it outlines how data analysis was done.

3.2 Study design

The study used a cross-sectional survey design to aid in collection data from sampled households involving both qualitative and quantitative research techniques (Creswell, 2005). The data was collected from respondents at a one point in time using a set of questions. The design aided in obtaining a snapshot picture of what was happening in the study area with regard to the topic of study. The approach relies on recall of individual respondents and discussions at the community to yield detailed data of a given research problem or issue within a short time and with limited resources (Kothari, 2004). Quantitative data was collected using semi-structured interviews through questionnaires while qualitative data was collected through semi-structured interviews, focus group discussions and key informant interviews.

3.3 Study area

This study was undertaken in Shinyalu sub-county, in Kakamega County. Shinyalu is situated in Western Kenya adjacent to the western portion of Kakamega forest, 35 km from Lake Victoria, and approximately 1.6 - 22.4 km east of Kakamega town (Kakamega Forest Ecosystem Strategic Management Plan, 2010; BIOTA, 2010). The Kakamega Forest Reserve borders the divisions of Ileho (North) and Shinyalu (South). See map showing study area on page 25.

The area is classified as moist mid-altitude zone (MM) (Lynam and Hassan, 1998). The MM zone forms a belt around Lake Victoria, from its shores at an altitude of 1110 meters up to 1500 meters above sea level. Shinyalu sub-county has a human population of 118,049 with four locations (KNBS, 2009). The inhabitants of Shinyalu are the Isukha of the Luhya tribe.

The family and household sizes are relatively large compared to the limited resources upon which the communities can depend on, with a small average farm size per household of about 0.5 acres. Access to land as a factor of production has been hindered by land fragmentation. (Kakamega Forest Ecosystem Strategic Management Plan, 2010-2020; BIOTA, 2010).

Shinyalu was selected for this study because it is a forest adjacent community. Its inhabitants have resorted to obtaining tree products from the forest because their small farms have been subdivided for crop production. It has therefore become a challenge planting trees on-farm due to the competing land uses and this has led to severe degradation of the forest.

3.3.1 Livelihoods

Shinyalu sub-county has good weather patterns that are suitable for agricultural activities. Crop farming is the major economic activity in the area and the main crops grown are sugarcane, maize, beans, cassava, finger millet and sorghum. Maize is however the staple food. Farmers also rear animals, mainly cattle, goats, sheep, pigs and chicken. Kakamega forest is the main tourist destination in the sub-county and is home to a large variety of flora and fauna. It has indigenous trees, large species of birds, butterflies, monkeys, snakes, baboons, hares, and rabbits. It also provides research sites for a number of institutions in the country. Other attractive activities include bull fighting and cock fighting. Self-employment is the second main economic activity in the area after agriculture. Sectors which form a substantial number of self-employed persons include the Jua Kali cottage industries and boda boda. In agriculture, self-employed persons engage mostly in land ploughing, weeding, bush clearing, planting, harvesting and post-harvest handling. Those who do not practice agriculture engage in mining, forestry, brick making and building construction.

3.3.2 Climate and soils

Kakamega has one of the highest levels of annual rainfall in Kenya. Rainfall in Kakamega is bimodal, the long rains fall between March and June while the short rains fall between September and October. The dry season begins at the end of December to February. The average annual rainfall ranges between 1250mm and 1750mm. (Kakamega Forest Ecosystem Strategic Management Plan, 2010; BIOTA, 2010).

The soils are mainly ferralo-orthic acrisols in the northern part of the County and ferralo-chromic/ orthic acrisols in the southern part of the County. Other minor soil types in the area are nitisols, cambosols, and planosols (Amadalo et al., 2003). The geology of the area is defined by underlying rocks that include basalt, phenolites and ancient gneisses of the Kavirondo and Nyanzian systems, which are associated with gold bearing quartz veins. The rocks form moderately fertile clay-loam soils (BIOTA, 2010). The rainfall amount and distribution, climate and fertile soils are conducive for a diversity of plants and animals. This biodiversity makes the area quite productive and conducive for agricultural activities that sustain the community's livelihood needs.

3.4 Study population

Shinyalu Sub-County had a total of 25,491 households residing in four locations (KNBS, 2009). The locations were Shibuye, Muranda, Khayega and Ilesi. Two of the locations (Shibuye and Muranda) were located close to the forest, stretching a radius of approximately 10km into the forest. The other two (Khayega and Ilesi) were located at a radius of approximately 20km from the forest edge (BIOTA, 2010). For purposes of this study, the two locations close to the forest i.e. Shibuye and Muranda were considered due to their proximity to the forest and the dependence of the locals on the forest for products and services. The two locations had a total of 13,411 households with Muranda having 5,991 households and Shibuye having 7,420 households (KNBS, 2009). A household in this study was treated as people living together and eating from the same pot.

3.4.1 Sampling procedure and sample size

The two selected locations in Shinyalu sub-county i.e. Muranda and Shibuye had a total of 13,411 households (KNBS, 2009). Sample size for the households was determined using the formula recommended by Mugenda and Mugenda (1999). The formular given as:-

$$n = \frac{z^2 pq}{e^2}$$

Where

n = the desired sample size if the target population is greater than 10, 000

z= the standard normal deviate at 95 % confidence interval

p= the proportion in the 13,411 households

q= 1-p

e= the level of statistical significance.

According Mugenda and Mugenda (1999), the value of P should be determined based on a pilot survey and when it is not available, a 50 % (maximum variability) is used.

Therefore: -

$$n = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} \quad = \quad 384$$

Therefore, 384 is the desired sample size for populations greater than 10,000.

The number of households in Muranda and Shibuye was 13,411 which are more than 10,000; the sample was therefore 384 households.

Proportionate sampling was used to select the number of households in each of the two locations. Proportionate allocations of the samples between Shibuye location, which had 7,420 households, and Muranda, which had 5,991 households, were applied. Therefore, 55% (211) of the households were sampled from Shibuye and 45% (173) were sampled from Muranda.

The table below indicates the number of households that were sampled in each of the two locations selected for this study.

Table 1: No. of sampled households in each location

Location	**Total no. of households**	**Sampled households**
Shibuye	7,420	211
Muranda	5,991	173
Total		384

The two Locations selected for the study had 4 Sub-locations each. Proportionate sampling was used to determine the number of households to be selected in each sub-location. Therefore, in Muranda Location, the following number of households was selected in each respective Sub-location: Mukulusu 51, Shisembe 31, Shiswa 62 and Itenyi 29. In Shibuye, the following number of households were selected, Virhembe 59, Mukango 38, Shing'oto 72 and Shiasava 42.

Simple random sampling was then used to select the number of households in each village in the Sub-location. A list of households in the villages in each Sub-location was obtained from the area Sub-chief. Every household in the list was allocated a number and the number of sampled households selected using a random number table. In Murhanda for instance, Mukulusu Sub-location had 6 villages with a total of 1,753 households, and only 51 households needed to be sampled. Since the population was 1,753, a 4 digit number, the first four digits of the numbers listed on the random number table were used. To get the first number that would guide the selection of the households to be sampled, a spot on the random number table was randomly pointed with closed eyes. If the first four digits of the number that was pointed fell between 1 and 1753, it was selected, the next number was looked at, if it fell between the required range it was also selected, if not, the number was skipped until the number that was within the required range was found. This was done until 51 numbers were selected that represented the 51 households randomly distributed amongst the 6 villages. In a case where the first number to be picked was not within the required range, then the next number was looked at until a number that fell within the range was found and the rest of the numbers selected as stated above after determining the first number.

Table 2: Sampling of households

Location / Sub-location	**No. of Households**	**Villages and Households sampled**	**Total No. of Sampled Households**
MURANDA			
Mukulusu	1,753	Lunyalala=8 Mayungu=12 Mukulusu=15 Navangala=5 Sasala=4 Shamiloli=7	51
Shisembe	1088	Nandakhula=11 Shisembe= 20	31
Shiswa	2144	Evonjo= 12 Ivochio= 18 Shiswa=32	62

Itenyi	1,006	Itenyi=11 Masiakali=4 Mikhango=5 Mulundu=9	29
Sub-Total	**5,991**		**173**
SHIBUYE Virhembe	2058	Lukambo=28 Secheno=12 Shipalo=19	59
Mukango	1325	Iluro=10 Mikhango=9 Mukango=15 Musembe=4	38
Shing'oto	2,532	Bucheseni=19 Bukukhumi=11 Bwitsende=5 Likhovero=17 Masiola=10 Shing'oto=6 Shitsava=4	72
Shiasava	1505	Amsavo=9 Bwichina=7 Ingakhwa=6 Irobo=12 Musabo=8	42
Sub-Total	**7420**		**211**
TOTAL	**13,411**		**384**

Source: Field survey, 2016

3.5 Data collected

The data for this study was obtained from both primary and secondary sources.

3.5.1 Primary data collected

Primary data was collected using Semi-structured interviews, Focus group discussions and Key informant interviews.

Semi-structured interviews

Semi-structured interviews were carried out to obtain socio-economic and demographic data (patterns and configurations of tree planting, income sources, total household income, farming practices, livestock size, education years of the household head, years of residence, household size, and land size).

Focus Group Discussions

Focus group discussions were held in the two selected locations: Shibuye and Muranda. One focus group discussion was held in each location with 10 discussants guided by a moderator. The discussants were selected purposively from the existing Community Forest Association in the respective location. Community Forest Association members were chosen because they protect the forest and would have been honest with their information. Each location had 1 Community Forest Association which was selected for the study. Both male and female discussants representing each of the 4 sub-locations in each location were selected. The discussions were captured by use of a voice recorder and through note taking. The recorded information was later transcribed. Every session of the FGD lasted for two hours. The qualitative data in this category was used to inform the three objectives of the study.

Key Informant Interviews

The study held 5 KIIs in each location i.e. Shibuye and Muranda. The interviews were conducted with purposively selected participants. 5 Key informants were selected from their respective locations and they comprised of the area Chief, the CFA Chair, a village elder, a female representative and a youth representative. The study area had a total of 4 Chiefs representing the 4 locations respectively. A key informant was selected based on the following criteria: familiarity with the area and the local people, having broad and in-depth knowledge of the village, its households and the forest uses. The interviews were recorded by use of voice recorder and through note taking. The recorded information was later

transcribed. The key informant interviews lasted for an hour for each session. Qualitative data from the KII with the elders was helpful in addressing the three objectives of the study.

3.5.2 Secondary data collected

Records from Kenya Forest Service and other forestry related CBOs in the study area were used to supplement primary data collected. Relevant publications on adoption of on-farm tree planting were reviewed, and, internet and library searches done.

3.6 Data analysis and presentation

The study used both qualitative and quantitative methods of data analysis. Qualitative data gathered through key informant interviews, semi-structured interviews and focus group discussions were analyzed using content analysis, which involved categorizing verbal or behavioural data in order to classify and summarize the data (Dudovskiy, 2018). Verbatim quotations were also used to capture direct presentation of information in order to avoid losing meaning and possible exaggerations. The quantitative data collected was edited in order to detect errors; it was then coded to put responses in a limited number of categories; and finally, entered into the statistical package for social sciences (SPSS) software version 22. The data was then analyzed using descriptive statistics and presented as percentages, frequencies, and means. The findings were presented in summary in form of texts, tables, graphs and pie charts.

3.7 Validity and Reliability

Piloting of the data collection tools was done in the neighboring locations with almost similar characteristics as the selected study area. This aided in ensuring that the instruments were tested and the questions well-structured to obtain relevant information in line with the study objectives.

3.8 Ethical Considerations

Permission to proceed with the study was obtained from Maseno University Ethics Review Committee (MUERC). Research participants were informed of the nature and relevance of the study. Informed consent was obtained from all participants and confidentiality maintained throughout the data collection and analysis process. Identification of names was not used

during qualitative data collection in this study. The data was stored both in hard and soft copies for a minimum of five years under the researcher's custody. The hard copy questionnaires were thereafter discarded through burning. A summary of the findings is available to the participants through dissemination process.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents an analysis and interpretation of the results from the data collected from the field. The results are presented based on the objectives posed in chapter one of this document. Three fundamental objectives drove the data collection and subsequent data analysis. These were, to assess the extent to which on-farm tree planting has been adopted, to determine factors influencing adoption of on-farm tree planting and to assess the contribution of on-farm tree planting to household income vis a vis other farming practices.

Extent to which on-farm tree planting has been adopted

4.2 Extent to which on-farming tree planting has been adopted

4.2.1 Patterns and configurations of tree planting

The survey indicated that the major patterns and configurations in the study area were distributed as follows: Majority of the farmers practiced woodlots (24%), trees on boundaries (23%) scattered trees on the farm (21%), Fruit trees (14%), Medicinal trees (10%), Contour ploughing (5%), Improved fallows (2%) and Fodder banks (1%) as outlined in figure 1 below.

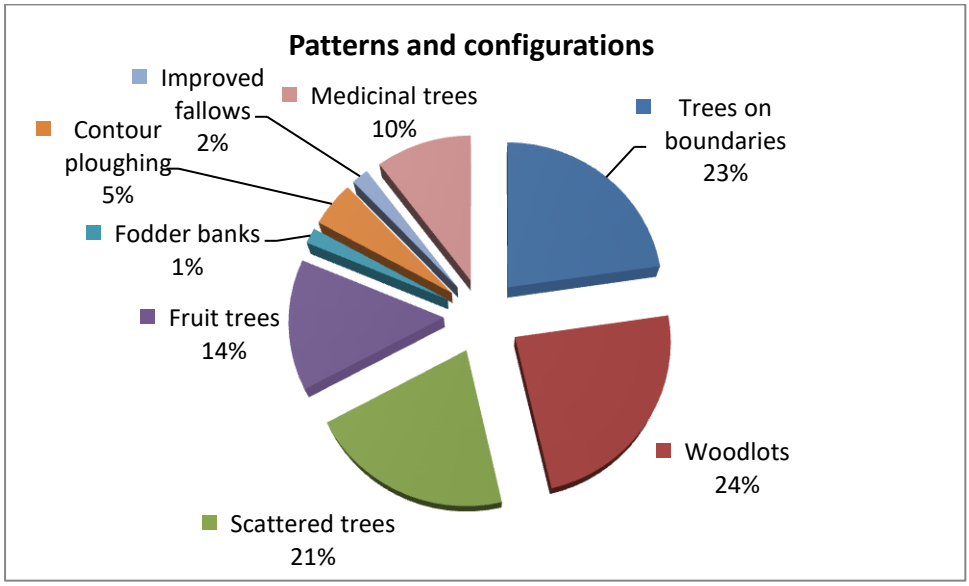


Figure 1: Patterns and configurations of tree planting

Woodlots (24%) were the most common pattern and configuration of tree planting in the study area because the area is characterized by crop farming (maize, sugarcane) which requires light for proper growth. The farmers therefore set aside small areas of land to plant trees far away from the crop farms to avoid the shade from the trees interfering with the crops. The World Agroforestry Centre (1994) asserts that woodlots are the best tree planting patterns and configurations to grow in areas where light-demanding crops such as maize and sugarcane are dominant. The choice to adopt woodlots as the most common pattern and configuration reflects the TPB tenet on attitude towards a behavior whereby a farmer feels planting a woodlot will prevent trees from blocking the light that food crops require hence; with a woodlot he will secure both the trees and the food crops which will get adequate light.

Trees on boundaries had been planted by 23% of the respondents because they aid in demarcation and marking boundaries of one's property. This pattern and configuration was very common in the study area as it saves the farmers the costs they would have otherwise incurred putting up either a barbed wire or a chain link fence. Once the trees have been planted on the boundary, they act as a permanent fence that cannot be altered. Trees often mark the boundary of one property with another; this is an ancient custom (Naturet, 2018).

Scattered trees (21%) had been planted mainly for their aesthetic value. The respondents indicated that scattered trees in the compound add beauty to the home and also increase the value of the land. Scattered trees make the surroundings more beautiful by adding colour to an area; they contribute to the character of their environment by enhancing unsightly views. They increase property values 5 to 15 percent more compared to properties without trees (Bordelon, 2018).

Fruit trees were planted by 14% of the respondents for food. The main fruit trees planted were mangoes, avocados and guavas. They were however not so popular because majority of the homesteads had only 2 to 3 fruit trees in their compound. Most of the respondents felt that it was not economical to plant so many fruit trees because they can only be used to provide fruits for domestic use and do not earn a lot of income even when sold. They therefore preferred to plant other high value tree species such as *Eucalyptus spp* that had multiple uses such as provision of firewood and timber. According to FAO (1986), in non-industrialized areas of the world, wood is the most widely used household fuel where supplying energy, constitutes the greatest demand for trees, far exceeding that of any other use. It is by far the most important energy source in many countries, accounting for up to 90% of the total fuel

used in some of the poorest. This means that most households would rather plant trees that provide good quality firewood than fruits.

The least practiced patterns and configurations were medicinal trees (10%), Contour ploughing (5%), Improved fallows (2%) and Fodder banks (1%). Medicinal trees (10%) were only common in households which had traditional herbalists who were very few in the area. Most households however, indicated that they believed in conventional medicine and were not keen on planting medicinal trees. Contour ploughing (5%) was not a common pattern because the landscape of the study area is relatively flat. Only a few slopes towards the rivers had this particular pattern and configuration. Improved fallows (2%) and fodder banks (1%) were not popular at all because of the small land sizes that cannot allow the farmers to either leave the land bare for a long period of time or allocate it to fodder while they need to plant crops to feed their families.

4.2.2 Reasons for preference of patterns and configurations

The study established the reasons why respondents preferred a particular tree planting pattern and configuration over the other. The woodlots were adopted mainly for timber and income and by 92 (24%) respondents. Trees on boundaries were adopted for land demarcation and boundary fencing by 88 (23%) respondents, scattered trees were adopted for firewood, shade, wind breaking, soil conservation and aesthetic value by 81 (21%) respondents. Improved fallows were adopted due to high competition with crops by 8 (2%) respondents. Contour ploughing was adopted for mixed cropping and soil erosion prevention by 19 (5%) respondents. Fodder banks were also adopted for mixed cropping and soil erosion prevention by 4 (1%) of the respondents. Fruit trees were adopted by 54 (14%) of the respondents for food and medicinal trees were adopted for medicine by 38 (10%) of the respondents.
See table 3 below:-

Table 3: Reasons for preference of patterns and configurations

Reason for preference of patterns and configurations	Patterns and configurations	No. of respondents n= 384	Percent (%)
Timber, income	Woodlots	92	24
Shade, wind breakers, aesthetic	Scattered trees	81	21

value, firewood, soil conservation			
Land demarcation and Boundary, Fencing	Trees on boundaries	88	23
Control high competition with crops and improve soil fertility	Improved fallows	8	2
Prevent soil erosion, Mixed cropping	Contour ploughing,	19	5
Prevent soil erosion, Mixed cropping	Fodder banks	4	1
Food	Fruit trees	54	14
Medicine	Medicinal trees	38	10

The main reasons why woodlots were preferred were provision of timber and income (92). Most households had planted the fastest growing trees, i.e. *Eucalyptus spp*, in their woodlots because land had been set aside entirely for trees and there was little need to worry about competition with crops. As a result, a high level of timber production for domestic or cash-income purposes which benefits the farmer is achieved in the area. A study done in the United States (Norland, 2011) similarly found that, woodlots have a lot of benefits to their owners such as providing income from selling wood and non-wood products. According to Kahuria (2017), in Kenya, Farmers living adjacent to forests in Kericho, Sururu, Bomet and Sotik areas are now enjoying better living standards after Kenya Forest Service (KFS) through Green Zones Development Support Project (GZDSP) impacted their lives through support in establishing woodlots on their farms. The farmers who were initially resistant to the idea of transforming their grazing land to woodlots for fear of making losses have benefitted greatly through commercial tree growing for timber production.

Trees on boundaries were mainly planted in the study area for land demarcation, boundaries and fencing (88). This particular pattern and configuration is widely adopted by most small-scale farmers who have small land sizes. This is because trees along boundaries do not interfere with crop land hence they do not jeopardize food security. Bunderson (2002) states that, boundary planting system diversifies land use, aids with wind breaking and improves soil fertility where fertility improving tree species are used and marks boundaries of land. It

also provides a source of fuel wood and poles for local uses. Other benefits include enhanced biodiversity through various flora and fauna that the trees environment might attract and support.

Scattered trees were preferred mainly for shade, wind breaking, aesthetic value, firewood and soil conservation (81). Majority of the respondents planted trees for the simple reason that they make the home look beautiful. They give the home a higher aesthetic value compared to a home that has no trees at all. According to Gibbons (2002), mature trees scattered on farm are critical habitats for some biota such as birds and provide a range of ecosystem services. Similar findings have shown that scattered trees provide shade for stock (Harvey & Haber, 1999) or shade-tolerant crops (Bentley et al., 2004), a buffer against soil acidity (Wilson, 2002), control against erosion and desertification (Plieninger et al., 2004), and insect control (Lumsden & Bennett, 2005) they are also a cost-effective source of seed for revegetation (Dorrough & Moxham, 2005). A study by Dobie and Sharma (2014) found that scattered trees have major benefits for poverty reduction and improving livelihoods, especially because their use and production can be under the control of the people who need them, they can provide immediate and urgently needed firewood for energy while providing a basis for many forms of modern energy for development.

Fodder banks and contour planting were adopted for soil erosion prevention and mixed cropping (4 and 19 respectively) in the study area. Other studies have shown similar reasons for adoption of these patterns. FAO (1986) asserts that forage legumes in fodder banks help minimize moisture runoff and soil erosion and help improve the fertility of the soil. In El Dovio, Colombia, mixed cropping is done in fodder banks where maize is intercropped with nacadero (*Trichanthera gigantean),* a multipurpose, versatile tree native of South America that thrives in a wide range of tropical ecosystems. It is used as fodder for pigs, rabbits and ruminants (Justin, 2013). According to FAO (1986), trees planted on the contour control erosion and provide organic material and nitrogen for the subsequent crops that have been intercropped (mixed cropping).

The main reason for adopting improved fallows in the study area was to control high competition with crops and improve soil fertility (8). The number of respondents were few because improved fallows were very rare in the study area. According to Tengnas (1994), this practice is relevant in areas where land is regularly fallowed. It is however not common in Kenya due to population pressure. It occurs in Western Kenya mainly in the Lake Victoria

basin and in semi-arid areas. It is only relevant where farms are relatively large, and there is no labour to take care of the large tracks of land.

4.2.3 Types of tree species planted on farm

Farmers were asked the tree species they planted on their land. Majority of the respondents indicated that they had planted *Eucalyptus spp.* 98% (372) on their farms, 86% (327) had *Croton macrostachyus*, 54% (207) had planted *Cupressus lusitanica*, while 53% (202) had planted *Persea americana* and *Grevillea robusta* had 49% (189) of the respondents as outlined in the table 4 below.

Table 4: Tree species and the number of trees planted

Scientific name/ Local name	**Number of trees planted**		
	% (N) of respondents	**Total no. of trees**	**Mean trees /Household**
Croton macrostachyus	86 (330)	6,036	19±3
Persea Americana	53 (204)	963	5±0
Grevillea robusta	49 (188)	12,190	66±12
Eucalyptus species	98 (376)	93,756	252±29
Olea capensis	10 (38)	1,316	34±3
Markhamia lutea	20 (77)	2,906	38±15
Carica papaya	5 (19)	179	10±4
Mangifera indica	27 (104)	382	4±0
Spathodeacampanulata	7 (27)	137	5±2
Psidium guajava	22 (84)	756	9±3
Cupressus lusitanica	54 (207)	19,417	94±16
Euphorbia tirucalli	3 (12)	95	10±2
Lucina leucocyma	8 (31)	471	15±3
Bridelia micrantha	8 (31)	142	5±1
Cordia Africana	3(12)	30	3±0
Pinus patula	2 (8)	42	6±1
Prunus africanus	15 (58)	932	16±4
Jacaranda mimosifolia	3 (12)	73	7±1

Ficus zur	2 (8)	122	14±11
Azadirachta indica	5 (19)	135	8±4
Trichiliaemetica	3 (12)	24	2±0

The most commonly grown tree species in Shinyalu was *Eucalyptus spp* by 98% of the respondents. According to the information received from the Focus Group Discussion in this study:

Katika sehemu hii ya Shinyalu ule mti ambao umepandwa zaidi katika maboma ni mti mbao unaojulikana kama Eucalyptus katika lugha ya kiingereza. Hii ni kwasababu mti huu una faida mingi sana kifedha kwa mkulima. Mti huu humea kwa kasi sana, na pia una mbao nzuri sana ambayo ukipeleka sokoni, unapata wateja kwa haraka. (FGD, 9th Nov., 2016).

Eucalyptus was the most common tree because of its high economic value. It produces very good timber that has high demand. It is also fast growing and therefore has quick returns to farmers. Most farmers in the area had planted large woodlots of eucalyptus for income generation. Other studies have shown that exotic tree species such as *Eucalyptus spp* grow fast, so planting them can reward farmers with a rapid income flow from their investment. Eucalyptus has been found to be a profitable alternative to farmers in several studies in developing countries (Jagger, Pender, & Gebremedhin, 2005; Jalota & Sangha, 2000; Kihiyo, 1996; Sharawi, 2006).

In Northern Ethiopia, eucalyptus trees are very profitable. The rate of returns for farmers' investments in eucalyptus is always above 20 percent (Jagger and Pender, 2003). According to Kidanu (2004), planting eucalyptus as field boundaries leads to stabilizing the livelihoods of resource-poor farmers and could help smallholder farmers increase their income and achieve food security. Kidanu (2004) also suggested that short rotation of a eucalyptus-based agroforestry system could be practiced in the seasonally-waterlogged highland vertisols. Holden et al. (2003) analyzed the potential of tree planting to improve household livelihood in the poorer areas of the Amhara in Ethiopia. They particularly considered the potential of planting eucalyptus trees as a strategy to reduce poverty in a less-favored area of the Ethiopian highlands. The results were impressive and they showed that planting eucalyptus on private lands unsuitable for crop production can substantially contribute to poverty reduction in these areas. The farmers' choice of *Eucalyptus spp* as the most preferred species in the study area reflects the TPB tenet on attitude towards a behavior where most farmers

believe planting it gives them more and quicker returns compared to other species because it is fast growing, it has a high demand and readily available market.

Croton macrostachyus had been planted by 86% of the respondents. The respondents noted that the tree is common in the area because its wood can be used as fuel that burns easily even when green. It is especially helpful during occasions such as funerals and weddings where a lot of firewood is needed and it becomes readily available because it does not require time for drying. They however stated that when burnt, it has an unpleasant spicy odour and a lot of smoke. It is also used for charcoal production and is commonly planted as a shade tree in the study area. According to Maundu (2005), the wood is used in Eastern and Southern Africa in carpentry, flooring and building material, to make tool handles, boxes, crates and plywood. It is considered useful for afforestation of shifting sand dunes, degraded waste land, hill slopes, ravines and lateritic soils due to its drought hardiness and fast growth. It is also grown as a hedge plant and is suitable for intercropping (Maundu, 2005). In Uganda sheep and goats browse old leaves but not the young ones. In Sudan the leaves are burnt to make vegetable salt (Maundu, 2005). Studies done in Ethiopia by Bekele-Tesemma (1993) showed that the leaves are used as green manure and fodder. The fruits are very popular with birds and could be used as poultry feed. The flowers are heavily scented and give a dark-amber coloured honey with a strong flavor. It is widely used in rituals in most African communities.

Cupressus lusitanica had been planted by (54%) of the respondents. The respondents indicated that it was planted mainly because of its evergreen property; it does not dry easily. It is also admired for its aesthetic value, especially as a live fence because it can easily be shaped into any desired design. Dewees (1995) indicated that, in Kenya, Cupressus is often grown by smallholders and harvested by pit-sawyers for sawn timber. According to Fern (2014), in Central America, Cupressus has been widely planted as a forestry tree at higher elevations in tropical and subtropical areas. It is planted in amenity areas because it is a beautiful tree. The young branches are usually used for decorations during all the festivities; and are also used for making wreaths for cemeteries.

Persea americana commonly known as avocado tree had been planted by 53% of the respondents mainly for income generation. Avocados are a common fruit in the area and are loved for their nutritional value and for sale. The area produces the best avocados in the country. Some of the respondents indicated that when avocados are in season, they transport them to Nairobi for sale in Gikomba market. A study by FAO (2001) found that *Persea*

americana is the most economically important species of the Lauraceae family with the world total product of over 2.5 million tonnes. In Mexico, a study by Javier-German (2011) found that due to the high economic importance of the avocado fruit, the food industry was showing a remarkable interest in processing and enhancing its value. The study further found that the consumption of avocado-derived products had also caught considerable attention in the country owing to its high nutritional value and reported health benefits, such as anticancer activity.

Grevillea robusta had been planted by 49% of the respondents in the study area. Farmers plant it because it is a fast growing tree and can be intercropped with food crops. It therefore does not require land to be set aside for it to be planted. It is popular for firewood and charcoal production in the area. Orwa (2009) states that *Grevillea robusta* provides abundant quantities of leaf mulch, which may accumulate to a depth of 30-40 cm which improves the soil fertility. This thick layer also protects the soil and maintains soil temperature. The leaves and twigs are also rich in aluminum. Topfarmer (2018) agrees with these findings by stating that when *Grevillea robusta* is incorporated on farms with crops like maize which take up a lot of soil nutrients and can exhaust the soil after a few years, leading to decline in yields, it helps to maintain soil fertility. It therefore saves the farmer on production costs that would have otherwise increased as the farmer attempts to increase yields quickly using chemical fertilizers, with subsequent reduction in profits. In a study carried out on evaluation of *Grevillea robusta* in boundary plantings in semi-arid Kenya, Tefera et al (1999) found that, farmers preferred *Grevillea robusta* for planting with crops as it was a relatively fast growing species and did not compete too much with other crops for water.

4.2.4 The survival rate of tree seedlings planted on-farm

The survival of planted seedlings determines the viability and adoption of technologies on farms. Only 21 respondents had planted seedlings and had above 50% of the total planted seedlings surviving. 40 respondents had 41-50% of the planted seedlings surviving. Majority of the respondents (270) had 31-40% of the planted seedlings surviving.

Table 5: Survival rate of planted tree seedlings

No. of Respondents	Tree survival (%)
8	0-10
15	11-20
21	50+
30	21-30
40	41-50
270	31-40

The low survival rate of planted seedlings can be attributed to the fact that most farmers are raising poor quality seedlings in their nurseries due to insufficient technical knowledge. These nurseries produce seedlings that have weak stems and lose leaves prematurely. As indicated by Kungu et al. (2008), when such seedlings are planted, they contribute to physical and chemical conditions that may be inappropriate for quality seedling development. Low survival rate leads to extra costs in replacement planting as well as delayed benefits. This makes farmers shy away from adopting on-farm tree planting.

The extent of adoption of on-farm tree planting in Shinyalu showed that the farmers have established woodlots, planted trees on the boundaries of their land and planted scattered trees for various purposes. Studies by Dewees (1995) on the role of trees in high potential agricultural areas to reflect the extent of tree cultivation and management found similar results. It showed that, in Kakamega County, woodlots and trees on boundaries cover an average of 7.4% of the area of agricultural land. Over 20% of the total land area has been used for growing trees, or has otherwise been left under natural woody biomass. Each household has also planted a variety of trees species on their land with Eucalyptus species coming up as the most important tree due to its good quality timber, fast growth and other factors. A study by Dewees (1991) found that in Kakamega, woodlots are almost always dominated by *Eucalyptus saligna.* This shows that the people highly regard trees and that is why they have set aside land to plant them because of their economic value and the other benefits. However, the survival rate of planted seedlings needs to be addressed because it is very low. The survival rate may pose a threat to afforestation whereby, when a farmer cuts a tree and would like to replace it, if the planted tree does survive, the tree cover will remain low and this will lead to eventual deforestation. This may discourage farmers from planting

trees in future, a situation that will lead to serious environmental degradation. Moustakas (2015) indicated that, tree seedling survival is a key factor in tree planting and forest dynamics, and the survival probabilities often determine the success of afforestation efforts.

4.3 Social factors influencing adoption of on-farm tree planting

The study determined the main social factors that influence adoption of on-farm tree planting in Shinyalu. The social factors that were ranked very important were: Access to existing forest/ distance to the forest (94.0%), gender (72.7%) Land size (71.4%), education level (68.2%), and family size (63.5%).

The responses of the Focus group discussions agreed with these findings:

Baadhi ya vitu ambavyo vinachangia urahisi ama ugumu wa upandaji wa miti ni shamba, na ukubwa wa familia. Ukiwa na shamba ndogo, upandaji wa miti unakua mgumu na ukiwa na shamba kubwa, ni rahisi sana kugawa sehemu ya kupanda miti. Familia kubwa pia inazuia upandaji wa miti kwasababu lazima shamba igawanywe kwa watoto wakiume na pia sehemu kubwa itengwe kwa upandaji wa chakula cha kulisha hii familia kubwa. (FGD, Nov., 2016).

The least important factors were: Access to credit (35.9%), age of household head (35.7%), and, farm and off-farm income (34.9).

Table 6: Social factors influencing adoption of on-farm tree planting

Social factors influencing adoption of on-farm tree planting	Rank of social factors influencing adoption of on farm tree planting			
	Important		Not important	
	No. of respondents	Percent (%)	No. of respondents	Percent (%)
Age	137	35.7	247	64.3
Land size	274	71.4	110	28.6
Family size	244	63.5	140	36.5
Farm and off-farm income	134	34.9	250	65.1
Education level	262	68.2	122	31.8
Access to existing forest	361	94.0	23	6.0

services/ Distance to the forest				
Gender	279	72.7	105	27.3
Access to credit	138	35.9	246	64.1

4.3.1 Age of the household head

The results of the study showed that age of the household was not an important factor in determining adoption of on-farm tree planting. The respondents who felt that age of the household head was not an important factor were 64.3% (247) while only 35.7% (137) felt it was very important (Table 6). Contrary to this scenario in Shinyalu, other studies have shown that, age affects the decision of farmers to participate in on-farm tree planting (Alassaf et al., 2011). Older farmers are more likely to participate in on-farm tree planting because their opportunities to be employed or engaged in other livelihood activities is more limited compared to younger people who tend to have more employment choices. In Vietnam, according to Thoai and Rañola (2010), age, which reflects upland farmer's farm experience, is one of the most important factors affecting the decision of upland farmers to participate in on-farm tree planting. Lwayo and Maritim (2003) support these findings by asserting that age and the decision to adopt farm forestry have a positive relationship. The age of the farmer affects knowledge and awareness of activities in the surrounding environment. Age, as concluded by Lwayo and Maritim (2003), affects one's ability to adopt farm forestry.

In Western Uganda, younger household heads are more likely to adopt on-farm tree planting compared to the older farmers (Thangata 1996). This is probably because the younger households are ready to take risk relative to older households and thus more likely to adopt on-farm tree planting. Adesina, et al. (2001), also agreed with this study by reporting adoption of tree planting decreases with advanced age. Age has largely been found to be significant in deciding whether to continue with the technology or not (Ajayi, et al., 2006). Older farmers were not willing to continue with the technology as compared to younger ones.

4.3.2 Family size of the household

The results of the study showed that households with family sizes of 10 members and above had an average of 65.9 trees, 7-9 members had 78 trees, 4-6 members had 83.6 trees while 1-3 members had 136.6 trees (Table 7). The respondents who felt family size of the household

was an important factor were 63.5% (244) while those who felt it was not were 36.5% (140). See table 6 above.

Table 7: Family size of the household and number of trees planted

No. of individuals in the household	Average No. of trees on-farm	Average No. of trees planted within 1 year
10 and above	65.90	15.93
7-9	78.01	17.60
4-6	83.62	24.83
1-3	136.67	42.79

The results of the study showed that family size of the household was rated as a very important factor influencing adoption of on-farm tree planting. Households with Family sizes of more than 10 members had planted fewer trees compared to family sizes of 1 -3 members. Therefore, the larger the family size, the lesser the number of trees planted. This can be explained by the cultural belief that sons in the home have to be sub-divided part of their father's land. As a result, households that have more children will plant fewer trees because the land that would have been used to plant trees has to be allocated to the male children. On the other hand, in cases where the children are many and they are female, fewer trees will still be planted because the land will be put under crop production to feed the large family size. This result is similar to a study by Alassaf et al. (2011) where he stated that depending on the number of people in the household and the size of the land they own, on-farm tree planting can either be taken up as a beneficial activity to the home or it may be looked at a waste of space that could otherwise be used for crop production to feed large family sizes. A study carried out in Rwanda has shown that households that have many children aged 16 and above including adults are more involved in farming activities (Ndayambanje et al., 2012). Thangata (1996) had a different opinion, contrary to the findings of this study. He stated that, the higher the number of children in a household, the higher the need for tree products and therefore the more the number of trees planted due to the readily available labour. Further analysis was done to determine the level of significant difference between the family size of the household and the number of trees planted. A p value of 0.498 showed that there was no significant difference between the number of trees planted and the family size of the household. This can be attributed to the fact that much as households with large family sizes

plant fewer trees, both the small and large households equally rely on trees for their products and services and therefore have to plant trees in order to get these products.

4.3.3 Effect of Farm and off- farm income on adoption of on-farm tree planting

In table 8 below, 134 (34.9%) respondents felt that farm and off farm income was an important factor while 250 (65.1%) felt it was not.

Table 8: Effect of farm and off-farm income

Responses on the effect of farm and off-farm income	No. of respondents	Percent (%)
No	250	65.1
Yes	134	34.9
Total	**384**	**100.0**

High unemployment rates have made it difficult for the locals to get off-farm income and therefore solely rely on their farms for their daily bread. The few available County Government jobs that could provide off-farm income are highly competitive with tough academic requirements that the locals cannot meet due to the high illiteracy levels in the area. In Ethiopia, the scenario is different. A study carried out by Mekonnen (1998) proved that, households with more income and higher proportion of off-farm income are more likely to plant trees. This could be the case because the households are financially stable and can therefore afford large tracks of land to allocate trees, but in Shinyalu, due to high poverty rates, the small farms can only be sub-divided so much to accommodate the homestead, crops, livestock and a few trees. Contrary to Mekonnen's study, a study by Ndambaje et al., (2012) found that, in Rwanda, households that have higher income are expected to plant less trees as compared to lower income households. This is because the high income households can afford to buy wood products and therefore do not need to plant trees.

4.3.4 Gender roles in tree establishment and management

The study results showed that husbands (men) were the main planters of trees (69.0%), tending (52.6%), ownership (64.1%) and they also decide when to harvest and cut the trees on the farm (67.0%). Table 8 on page 47 shows that 72.7% (279) of the respondents felt that

gender is a very important factor while 27.3% (105) felt that it is not an important factor. Gender is therefore an important factor in determining adoption of on-farm tree planting as the community preconceives tree planting as a man's job.

Table 9: Allocation of gender roles in tree establishment management

Activity	Responsibility	No. of respondents	Percent (%)
Tree planting	Wife	13	3.4
	Husband	265	69.0
	Both wife and husband	16	4.2
	Children	44	11.5
	Whole family	44	11.5
	Workers	2	0.5
Tending of trees	Wife	53	13.8
	Husband	202	52.6
	Both wife and husband	46	12.0
	Children	15	3.9
	Whole family	68	17.7
Tree ownership	Wife	48	12.5
	Husband	246	64.1
	Both wife and husband	35	9.1
	Children	10	2.6
	Whole family	45	11.7
Decision making (when and how to harvest)	Wife	55	14.3
	Husband	257	67.0
	Both wife and husband	32	8.3
	Children	9	2.3
	Whole family	31	8.1

In most of the households, the man was in charge of allocation of land use practices and management. See table 9 above. This could be attributed to the fact that cultural beliefs inhibit women from planting or taking care of trees. It is believed that tree planting is a man's job. This reflects the TPB tenet of perceived behavioral control in land ownership and tree planting where the perception of trees being owned by men makes women not engage in tree

planting activities. This tenet controls the behaviour of the women with regard to tree planting as dictated by the cultural beliefs. The responses from the Focus group discussions indicated that:-

Katika mila ya waluhya, wanawake hawaruhusiwi kupanda miti katika boma ambalo lina mzee. Kazi ya upandaji wa miti inajulikana kuwa kazi ya wanaume. Kazi ya wanawake ni kulinda boma na watoto. Kazi ya miti ni ya wanaume. Kwa hivyo jinsia inachangia pakubwa katika upandaji wa miti katika sehemu hii ya Shinyalu." (FGD, 9th Nov., 2016).

A study by Pattanayak et al. (2003) had a similar opinion. They found that male headed households or households with more male members were more active in tree planting. A study done in Jordan by Thoai and Rañola (2010) had a different opinion from this study. It figured out that women are more associated with the decision to plant trees on-farm. The male household head and the young children would rather not engage in on-farm tree planting, they would prefer other financially stable work. This shows that as much as in Shinyalu, women are not allowed to plant trees, in other countries, it is a woman's job. According to Randolph and Sanders (1992), In Rwanda, women contribute 40-80% of agricultural farm labour, much as they have husbands in the home. They are therefore the decision makers in crop production and on-farm tree planting.

Koirala et al. (2015) found that, women comprise almost half of the farming labor force in Africa and Asia, and therefore their participation in tree planting is increasing even though tree planting used to be a male-profession. Quisumbing et al. (2014) added that in Phillipines, women are also equally and actively involved in tree planting activities, though there is an unequal access to resources and opportunities between men and women farmers. Layton and MacPhail (2013) argued that women farmers receive less tree planting training and credit in Phillipines which has led to, gender-sensitivity being considered in designing current agroforestry programs.

A study on household gender roles and adoption of agroforestry by Okango (2015) that had similar results to this study found that, men undertake work that requires a lot of physical energy such as land preparation, tree planting, livestock herding and generally jobs that are perceived prestigious by members of the society. Women on the other hand carry out repetitious extremely boring, time consuming tasks like weeding what has already been planted by the man, fetching water and firewood and those tasks that are located close to the home such as care of the kitchen garden, milking and nurturing of children. Their work is

perceived less prestigious than men's work. As the household head, the man is therefore always in charge of tree planting activities in the study area.

4.3.5 Access to credit facilities by the household head

Majority of the household heads did not own bank accounts and had never accessed credit in any financial institution as indicated by the results in figure 4 below. Those who did not have bank accounts were 85.5%, those who did were 14.5%, while those who had never accessed any credit facilities were 90.8% and those who had accessed credit were 9.2%. This therefore means that access to credit facilities is not an important factor in determining adoption of on-farm tree planting as indicated in table 8 page 47 where 35.9% (138) felt it is a very important factor while majority, 64.1% (246) felt it is not important at all in adoption of on-farm tree planting.

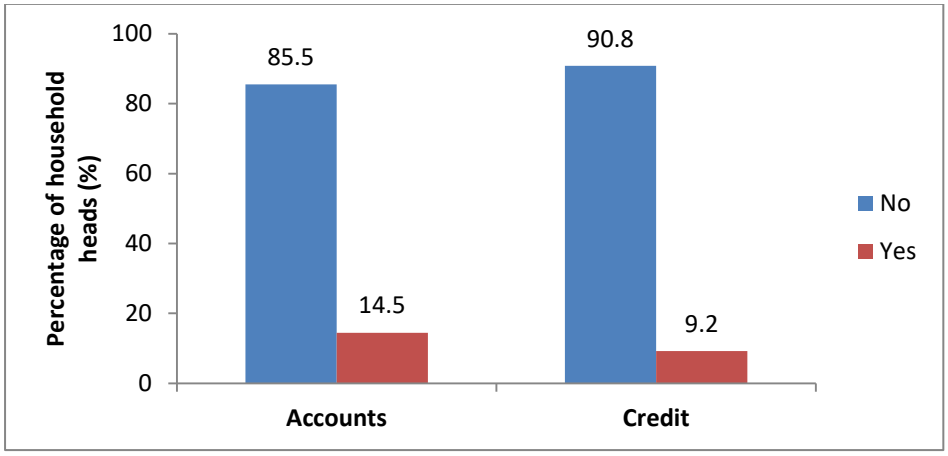


Figure 2: Access to credit facilities

This could be the case because most of these households do not have a large source of income, the little they make from the sale of farm produce is sufficient to provide for the family at that particular moment in time without any surplus remaining for saving. They therefore see no need of opening bank accounts without an adequate and consistent source of income. A study carried out in Central Kenya by Oeba et al., (2012) showed that those who had off-farm employment opportunities, access to credit and total household income may be associated with reduced tree felling on farm leading to high probability of tree retention. Access to credit enables a farmer to buy or rent land for tree planting, he will also be able to buy high quality tree seedlings that when planted will have a high survival rate and therefore

enhance on-farm tree planting. This is contrary to the study where access to credit has no effect at all on adoption of on-farm tree planting.

According to Carnea (1992), access to credit facilities should be given to farmers as incentives to stimulate small-scale tree planting. Other authors, however, feel credit should only be provided if it is well targeted and actually needed (Haltia and Keipi, 1997). The very poor who do not have access to credit or loans for tree planting and management should be given priority. Some authors, however, have criticized access to credit and loans as they can cause dependency and be risky if expected out-comes are not reached (Arnold, 1997).
According to Haltia and Keipi, (1997), Thacher et al., (1997), access to credit could either have a positive outcome for tree planting, or it can lead to unsustainable tree plantations. If a farmer is only interested in tree planting to make money, then, chances are that he may not manage the plantation well and the yields will not also be of good quality. It is therefore very important that the farmer has good intentions of tendering and managing well the trees he has planted from the money given on credit.

4.3.6 Education Level of the household head

Table 10 below shows that there was a strong relationship between education level of the household head and the average number of trees planted on-farm. It was a very important factor because the most educated people had more trees on their farms. Table 10 indicates that those with University education had a mean of 400 trees on their farms, college had 245.92, those with secondary education had 70.92, primary education had 30.77 and lastly those with no education had 20.50 trees on their farms.

Table 10: Level of education and the mean number of trees planted

Highest education level	Number of trees (Mean)	No. of respondents
University	400.00	1
College	245.92	42
Secondary	70.92	149
Primary	30.77	177
None	20.50	15
Total		**384**

The above results are probably because, those who are learned have more knowledge on the proper ways to plant trees, the best quality of seedlings and the right species to plant. They could also be more financially stable since going to school has made them get well-paying jobs and therefore earn more income to enable them acquire large tracks of land to place under tree planting. Another possibility could be that the more educated people understand the need to conserve trees and therefore they do not cut them aimlessly. They could also be less dependent on trees for firewood which reduces the number of trees on-farm because they can afford to buy cooking gas as an alternative source of energy.

Other studies have shown a similar result; the level of education of the household head has a positive effect on on-farm tree planting. People who are more educated have more income opportunities. They can afford to put more land under tree planting (Haglund et al., 2011; Muhammad et al., 2011). According to Brahmi and Thakur, (2011) and Alassaf et al., (2011), illiteracy greatly contributes to one's decision not to plant trees on their farm. Lwayo and Maritim (2003) also indicated that formal education is a vital aspect in a farmer's decision to adopt on-farm tree planting and it influences the effectiveness of the decision to participate in such activities. A farmer who is formally educated can readily have access to information on the value of farm forestry and therefore take up the practice easily. Naidu (1992) also stated that education and people's participation were very important factors in on-farm tree planting.

Blaug (1972) asserted that one's ability to capitalize on opportunities is improved by education. An educated person is generally more flexible and more motivated. He adapts himself more easily to changing circumstances. He benefits more from work experience and training, and, acts with greater initiative in problem-solving situations (Blaug, 1972). In general, an educated person is more productive than a less educated person, even when his education has taught him no specific skills (Blaug, 1972). Similar findings (Masangano, 1996) revealed that education is positively associated with the probability to adopt agroforestry technologies. Thangata (1996) also observed that education level of the household head is an important determinant of adoption of on-farm tree planting because formal and informal training has the potential to increase the rate of adoption by directly increasing awareness, imparting skills and knowledge of the new technology. A study done in Rondonia, Brazil, Campeche, and in Mexico indicated that exposure to information about tree

planting and the level of educational achievement all play significant roles in the decision to adopt on-farm tree planting (Casey et al., 2000).

Contrary to the above, Thoai and Rañola (2010) concluded that the level of education is not an important factor affecting an upland farmer's decision to either take up or not on-farm tree planting in the northwest mountainous regions of Vietnam. This is because though the upland farmers are more educated than the minority groups, they are still bound by strict rules regarding the importance of tree planting. This compels both the educated upland farmers and the uneducated minority groups whose livelihoods depend so much on the forests and trees to plant them in adherence to the community rules regarding forestry. A p value of 0.029 showed that there was a significant difference between the number of trees planted and the household head's education level.

4.3.7 Land size of the household head and on-farm tree planting adoption

The land sizes varied with majority 258 (67.2%) of the respondents having land sizes of less than 2 acres, and very few 30 (7.8%) having 4.5 acres and above. The 67.2% who owned less than 2.0 acres had a mean of 150.67 trees while those who had more than 4.5 acres planted a mean of 535.55 trees (Table 11).

Table 11: Land size and mean no. of trees planted

Acreage	Mean no. of trees planted	No. of respondents	Percent (%)
≤ 2.0 acres	150.67	258	67.2
2.1-3.0 acres	155.27	70	18.2
3.1-4.5 acres	319.88	26	6.8
4.5 ≥	535.55	30	7.8
Total		**384**	**100.0**

The statistical analysis (p value of 0.001) showed there was a significant difference between the land size and the number of trees planted. This is probably because, the land sizes in the study area are very small for tree planting considering other competing farming practices that households equally rely on for their various needs. These small land sizes amount to great

pressure on the land hence difficulty in adopting on-farm tree planting. Other studies have shown that land size has a positive association with farmers' decisions to plant trees on their farms (Ajayi et al. 2003). Salam et al., (2000), and Summers et al., (2004) agreed with the results of this study by asserting that tree planting farmers own larger land areas compared to non-tree planters, a pattern found in other studies in the tropics. Most of the small-scale farmers in many African societies fall within the customary tenure system whereby families depend on acquiring land through ancestry accession. This means that each family is restricted to sharing land that belongs to their forefathers. Therefore, as family size increases, their share of land gets smaller since they have to pass on portions to the younger generation. As a result, the land is too small to plant trees and food production has to be prioritized.

It is evident that farmers with larger areas of land tend to plant and manage trees more than the farmers with limited land (Amacher et al., 1993, Thacher et al., 1997, Summers et al., 2004). Contrary to the study, other findings by Scherr (1997) have shown that, at times, poor farmers with small land areas have high densities of trees on part of their farms, because they are dependent on essential forests products such as firewood that may be otherwise scarce. Furthermore, as farmers are often highly dependent on the limited resources produced on their land for their livelihoods, they have an incentive for managing their crops, including trees, in the most sustainable and efficient way (Sen and Das, 1988). Scherr (2004) points out the advantage of having a small land size. He states that small land areas can be more easily protected from damage such as forest fires or diseases, and there is an incentive to focus on quality production. He adds that they may have disadvantages too because they provide small volumes of wood, which can make harvesting and transportation to the market uneconomical.

Land ownership and on-farm tree planting adoption

The results of the study showed that there were 3 types of land ownership in the study area, 40.4% (155) of the respondents had individual ownership with a mean land size of 0.79 acres, 59.1% (227) had family ownership with a mean land size of 1.02 acres and 0.5% (2) had rented land with a mean land size of 0.5 acres (Table 12). This came out clearly in the Key Informant Interviews as well:-

Ingawa mashamba yetu ni madogo, kuna wale wana mashamba yao kibinafsi, kuna wale wana mashamba ya familia na kuna wale ambao hawana mashamba kabisa, wakihitaji kupanda vyakula, huwa wanakodisha. (KII, 8th Nov., 2016).

Table 12: Type of land ownership and mean acreage owned

Type of ownership	Mean (Acres)	No. of respondents	Percentage (%)
Individual	0.7931	155	40.4%
Family	1.0288	227	59.1%
Rental	0.5000	2	0.5%
Total		**384**	**100**

Despite the fact that these land sizes are relatively small, the type of ownership is also quite limiting to allocation of land to tree planting. 59.1% (227) of the respondents have land that is owned by the entire extended family. This means that the land is divided amongst all the children in the home and these children are grown up men with families, and they also need to sub-divide the small portions of land they have to their male children. This reflects the TPB tenet on perceived behavioural control where the farmers' need to plant trees on their land is controlled because they have to subdivide the land amongst the sons in the home.

Owing to the fact that some farmers do not own land, they end up cultivating on borrowed or rented land. In this circumstance, long term investments on land such as tree planting would not be feasible for them. According to Angelsen (2003), the relatively long time periods involved in tree farming exposes farmers to risks in terms of price fluctuations, tenure insecurity and natural hazards. The long waiting period and high risks do not favor poor farmers, who are highly dependent on their limited farm resources; often for day to day survival (Dewees and Saxena, 1997). The only farmers who are able to cope with the extended payback period between tree planting and harvesting are those with on-farm food supply, off-farm income sources, or access to affordable loans (Arnold, 1997). A study by Salam et al (2000) showed that the poorest farmers in the tropics rarely own land, have little access to private land and own very small areas of land. They therefore have little or no choice but to plant staple food crops that provide annual returns, instead of the relatively slow growing trees that require more land.

Land use system and on-farm tree planting adoption

The study also determined the land use system in the area, and it was evident that 99.5% of the respondents had crop cultivation as the main farming practice, 63.8% had tree planting, while 45.8% reared livestock (Table 13).

Table 13: Land use system and mean acreage allocated

Land use system	Mean (Acres)	No. of respondents	Percent (%)
Crop cultivation	0.92	382	99.5
Livestock rearing paddocks	0.47	176	45.8
Fodder crop cultivation	0.46	114	29.6
Homestead	0.42	371	96.6
Fruit orchard	0.34	60	15.6
Woodlot	0.56	245	63.8

Crop cultivation (99.5%) is popular in the study area probably because of the large families that need to be fed and the small farms that cannot accommodate tree planting alone and leave out crop farming. In some instances, the need for agricultural land has seen trees being cleared in order to plant food crops and keep livestock. A study by Bajracharya (1983) found that the main reason why people cut down trees is to clear land for agricultural cultivation and for pasturage. This may be the cheapest and easiest method of increasing production within an agricultural economy. According to FAO (1986), in rural areas where there is not enough land to absorb growing agricultural populations, pressures on the already cultivated land become even more intense. Through inheritance, the division of property among family members and land sales, average landholding sizes decrease. As the resources available to the household become fewer, trees may be seen as a resource which must be sacrificed in order to meet more urgent household needs. The TPB tenet on perceived behavioural control is reflected in the land use system whereby, the farmer's desire to plant trees is controlled by the need to plant food crops on the small land sizes they own so that they can feed their families.

4.3.8 Distance from the household to the forest and trees planted

The results indicated that distance from the household to the forest contributed to the number of trees planted on-farm in the study area. Table 14 below indicates that there were fewer trees planted (398.4) at a distance of less than 0.5 km from the house to the nearest forest edge and more trees (823.3) planted at a distance of 1.6-2.0 km further from the forest.

Table 14: Trees planted and distance to the forest

Distance (km)	Mean No. of trees planted
≤0.5	398.4
0.6-1.0	576.9
1.1-1.5	697.8
1.6-2.0	823.3

This could be the case because those households that are located close to the forest feel that the forest can provide their tree product needs and they therefore do not have to plant trees. They also feel that the forest is nearby, and it would be very easy for them to walk there to collect firewood for instance, several times in a day without getting tired. On the other hand, households that are located far away from the forest would find it an uphill task walking for over 2km in search of firewood, so they would rather plant their own trees to supply their tree needs. Previous studies have shown similar results to the above. According to Oli (2014), in a study done in Nepal on the determinants of growing trees on-farms in the middle hills of Nepal, the distance between household dwellings and the forest were positively related with on-farm tree growing adoption. Households that were located closer to the forest planted fewer trees than those further from the forest. Similar results in line with these results were obtained in a study done by Duguma and Hager (2010) which found that distance from the household dwelling to the forest was positively associated with trees on farm land, probably because larger distances imply higher costs of forest product extraction. However, the results of the analysis of variance showed that there is no significant difference between distance from the household to the forest and the number of trees planted ($p = 0.172$). This is because irrespective of the distance from the household to the forest and the number of trees planted on the farms, the respondents still source for more products from the forest.

Distance to the forest and forests products obtained

The results of the study further showed that those that live near the forest sourced more products from the forest at a higher frequency than those that live far from the forest. For example, a person that lives less than 1.5km gets a mean of 2.52 head loads of firewood at an average of 13.55 times in a month while one who lives more than 1.5km from the forest gets a mean of 1.83 head loads 7.14 times in a month.

Table 15: Distance to the forest and forest products obtained

Distance	Products	Units	Mean Quantity obtained	Average times per month
≤1.5km	Firewood	Head load	2.52	13.55
	Grass for fodder	Bundle	2.75	7.40
	Grazing	Number	7.00	28.00
	Medicinal extracts	Kg	4.00	5.00
1.5Km≥	Firewood	Head load	1.83	7.14
	Grazing	Number	4.67	17.50

This is the case probably because farmers are comfortable taking advantage of the nearby forest rather than planting trees on their own farms. According to Lionberger (1960), Raintree (1983), Rogers (1995), farmers may not incorporate trees on their farms for tree products if there is no perceived shortage of tree products, even if there is severe deforestation. They would rather destroy the forest that is near them than plant trees on their farms. Similar results by Richards et al. (2003) have found that people living near the forest often use these forests extra-legally especially in collection of wood fuel, construction and fencing material. Coomes and Burt, (2001), also agree by indicating that the communities nearest to the forest obtain more products from the forest. They add that, though people nearest to the forest have the lowest transaction costs in accessing the forest products the people further away obtain a higher value of products. This may have been because the people nearest to the forest collect small quantities at a time as they can easily access the forest. Those far away on the other hand collect larger amounts of products that are valued more to avoid frequent visits characterized by long tedious distances to the forest. A p value of 0.251 showed that there was no significant difference between the distance to the forest and quantity of products obtained. This implies that the products obtained from trees on farms cannot adequately sustain the needs of the households irrespective of the distance they live from the forest, making them still source more products from the forest.

4.4 Contribution of on-farm tree planting to households' income vis-a-vis other farming practices.

The study determined the contribution of on-farm tree planting to households' income in comparison to other farming practices. It determined the other farming practices in the study area apart from on-farm tree planting and the reason why they were preferred. It also determined the contribution of each farming practice to household income as discussed below.

4.4.1 Reason for preference of other farming practices apart from on-farm tree planting

The study sought to determine the other important farming practices in the area and why they were preferred over tree planting. The results of the analysis showed that apart from on-farm tree planting there were 3 other main farming practices in Shinyalu Sub-County: Crop production, livestock rearing and beekeeping. According to the Key Informant Interviews:

Wakulima hupanda vyakula kama mahindi, wanaweka ng'ombe, wanapanda miti na kuweka nyuki wa asali katika mashamba yao. (KII, 8th Nov., 2016).

The most important farming practice was crop production with majority of the respondents 286 (74.5%), ranking it highly for food while 98 (25.5%) preferred it for income (See table 16 below). The second most important practice was livestock keeping/dairy farming being highly ranked for income/sale 238 (70%), food 121 (31.5%) and manure 25 (6.5%). The least important farming practice was bee keeping which all the respondents who practiced it 23 (100%) did it for income generation.

Table 16: Reason for preference of other farming practices

Farming practices	Reason for preference	No. of respondents	Percentage %
Crop production	Food	286	74.5
	Income/ Sale	98	25.5
	Manure	0	0
Livestock keeping/ dairy farming	Food	121	31.5
	Income/ Sale	238	70.0
	Manure	25	6.5

Bee keeping	Food	0	0
	Income/ Sale	23	100
	Manure	0	0

Crop production was the most popular farming practice in the area because majority of the inhabitants were subsistence farmers. They grow maize as the main crop mainly to feed their large families. The small land sizes and high poverty rates also limit the kinds of activities that can be carried out in this area. According to Thacher et al. (1997) and Kumar (2003) Farmers with small land sizes and resources prefer agriculture or off-farm employment over tree planting for food security reasons; a situation that has been described in other developing countries. Byron (2001) in agreement with the results of the study stated that, farmers with more resources are able to cope with the long waiting period before receiving the income from wood; thus a lack of capital and land can be a major barrier to engaging in tree planting for poor farmers.

In Shinyalu Sub-County, priority is therefore given to food production for domestic and commercial use in case of surplus. According to Alila (2006) crop production is the backbone of the Kenyan economy. A report by the Republic of Kenya (2005) states that crop production contributes approximately 25% of the GDP, and employs 75% of the national labor force making it the most important sector in the economy. Above 80% of the Kenyan population live in the rural areas and derive their livelihoods, directly or indirectly from crop farming. Due to its importance, the performance of the sector is therefore reflected in the performance of the whole economy. It aids in poverty reduction since most of the vulnerable groups, those who do not have land, and subsistence farmers, also depend on it as their main source of livelihoods. Growth in the sector is therefore expected to have a greater impact on a larger section of the population than any other sector. Lack of guarantee for markets for maize produce has compounded the problem as farmers have no incentive to invest in productivity increasing practices. The results of the study found that only 25.5% (101) preferred crop farming for income/sale. Republic of Kenya, (2005) agrees with this finding by stating that lack of guarantee for markets for maize produce has made it difficult for farmers as they have no incentive to invest in productivity increasing practices.

Livestock farming was the second most popular farming practice in Shinyalu Sub-County. From the focus group discussions, it came out clearly that livestock was highly valued in the area with each home having an average of at least 3 cows for milk production and for sale

when need arises like payment of school fees. The milk is mainly sold to neighbours in small quantities such as 3 liters per day and for those who are involved in large-scale production selling it to retailers in quantities of up to 10 liters per day. Only a small amount of the milk produced is consumed at home, and that is why in table 18 above, only 31.5% (121) of the respondents keep dairy cows for food compared to the majority 70% (238) that prefer it for income generation. A small percentage (6.5%) of the respondents however, keeps livestock for manure. The Republic of Kenya (2002) agrees with these findings by stating that livestock farming supplies the domestic requirements of meat, milk, dairy products and other livestock products, and accounts for about 30% of all marketed agricultural output. According to Sansoucy (1995), in a study on the contribution of livestock to food security and sustainable development, livestock farming is a major component of the agricultural economy of developing countries. He adds that, farmers get direct cash income from sales of livestock and their products. Hossain (1988) found that in Bangladesh, the importance of livestock as a source of income for poor farmers is illustrated by the fact that the Grameen Bank, which assists the very poor provides nearly 50 per cent of its loans for the purchase of livestock. It purchases large ruminants for milk production and fattening for sale. A study done in India by Kulkarni et al. (1989) found that diary produce is the most regular income generator. It has been shown to increase income, consumption and repayment capacity in India.

Bee keeping was the least popular farming practice with only a few homesteads that have woodlots and beehives practicing it. All the 23 (100%) respondents who practiced bee farming did it for income generation. The practice was not common in most homesteads as the household heads claimed they could not afford to install beehives. It also has major challenges which discourage most farmers such as theft of honey, vandalism of hives, stings by bees, lack of skills in managing bees, and unreliability of production as it is a seasonal practice. The National Farmers Information Service (2018) agrees with the findings by stating that though bee keeping in Kenya has been practiced traditionally for many years only 20% of the country's honey production potential has been tapped. This is mainly because of the challenges involved in the practice. A study carried out in Tanzania by Mwakatobe (2005) found that bee keeping is an important source of income especially for communities living close to forests and woodlands. It also plays a major role in socio-economic development. Income from selling bee products subsidized household economies by at least 30% (Mwakatobe, 2005). In Baringo County, Moraa (2017) found that women have

embraced bee keeping as an alternative source of income during the dry season. They make products from honey and honey combs which they sell and pool their profits in a fund from which members can take out loans with a 1% interest rate. This has allowed them to expand their operation and buy more beehives and a hectare of land in their village where they plan to set up a honey processing plant.

4.4.2 Contribution of farming practices to household income

The study sought to determine the contribution of various farming practices to household income in comparison to on-farm tree planting in order to understand why they were either preferred over it or not. The results of the study showed that 86.5% of the respondents had received a mean annual income of Kshs 140,847.14 from crop sales, 52.9% of the respondents had received Kshs 71,500.50 from livestock sales, 62.2% of the respondents had received Kshs 90,547.74 from livestock products, and, 75.2% of the respondents had received an income of Kshs 105,616.55 from sale of trees and tree products.

The income from crop farming was determined by approximating the amount of income earned from the sale of crops per season in every household. Crops were grown in 2 seasons in a year; the amount earned from the two seasons was then used to determine the mean annual income. Income earned from livestock sales was determined by getting the amount of money earned from livestock sales in every household and doing the mean for the whole year. Income from Livestock products (dairy) was determined by getting the monthly income from every household and computing it for the whole year. The amount of income earned from the sale of trees and tree products was determined by getting income from tree and tree product sales from every household within a year. A p value of 0.001 showed that there was significant difference between the farming practice and the amount of income contributed to the household. This is probably because as much as each farming practice has a certain degree of importance to the farmer, there are those that earn more income and the household relies on them so much for their livelihood, hence they tend to be preferred most.

Table 17: Income from various farming practices

Activity	No. of respondents	Percent (%)	Mean annual income (KES)
Crop sales	332	86.5	140,847.14
Livestock sales	203	52.9	71,500.50
Livestock products (Milk)	239	62.2	90,547.74
Sale of tree and tree products	290	75.2	105,616.55

Contribution of crop farming to household income

The study observed that majority of the respondents (86.5%) had earned a mean annual income of Kshs 140.847.14 from sale of crops from their farms (Table 17). The main crop grown in Shinyalu Sub-County is maize because it is the staple food in the area. Mantel (1997) had a similar opinion that maize production in Kenya is a very crucial activity due to its importance as a dominant food crop. In the larger East Africa, majority of households are engaged in small-scale farming for income generation and for a significant share of their food (Cochrane and D'Souza, 2015). Agricultural production in Tanzania provides employment and source of livelihood to about 80% of its people and it contributes 27% of GDP and 35% of foreign currency (Muhihi et al., 2012). Maize farming in Shinyalu gives a mean annual income of Kshs 140,847.14, from two seasons of harvesting in a year. The maize stalks and maize cobs are also used as animal feed and this ensures that the livestock are well fed and even increase the production of milk for dairy cattle. Similarly, according to Ngurumwa (2016) in developed countries, maize is used as an important component in animal feed and also used widely in industrial products like in the production of bio fuels. The demand for maize has changed from a food crop due to a remarkable demand increase as a livestock feed over the past decade. Farmers in Shinyalu also prefer growing it because besides being a staple food, it has a short payback horizon. It takes quite a short time to get income from the crop once it has been planted. Crops such as maize are planted at least twice in a year; this means the income that the farmer gets after the first harvest can be able to sustain him until the second harvest.

According to Suleiman (2015), Maize has been identified as a significant crop for enhancing poverty alleviation, source of income, food production and food security. Opara (2013) asserts that the level of household income is a key determinant of a household's ability to

spend on food which also measures household's food accessibility. This means that if a household has a steady source of income, it will be able to meet its food needs and improve the livelihoods of the people living in that house. Every household however has a limited amount of resources at its disposal, which include assets, labour, human capital, and natural resources. When these resources are allocated to maize production, wages for labour or other business activities, the households are able to access food, either directly through food production or indirectly through income generation (Pieters et al., 2013). In Tanzania, the scenario is similar to Kenya. It is the Smallholder farmers that produce about 85% of the total maize production, leaving some 10% and 5% of the production to medium and large-scale farms respectively (Mtaki, 2016). This shows that indeed, maize is an important source of income for small scale farmers in most developing countries.

Contribution of livestock farming to household income

The results of the study showed that 52.9% of the respondents got a mean annual income of approximately Kshs 71,500.50 per year from the sale of livestock while 62.2% of the respondents got a mean annual income of Kshs 90,547.74 per year from the sale of dairy products. According to the Focus Group Discussions:-

Kila boma lina angalau ng'ombe watatu wa maziwa ya kutumia nyumbani na pia yakiwa mengi, yanauzwa kwa majirani. (FGD, 9th Nov., 2016).

It was however noted that the sale of livestock was not a common practice in the area. Livestock were strictly sold for very specific reasons such as lack of school fees and hospital bills. So it may take a long period of time to earn income from the sale of livestock. On the other hand, sale of dairy products is common in the area with most households selling at least 10 litres of milk per day.

In Kenya, livestock products are used for private consumption, as inputs into other domestic industries, and as exports (KNBS, 2010). The KNBS (2010) further states that 11.4% of household consumption expenditure that is spent on livestock-derived products is 13.1% in rural and 9.7 % in urban Kenya. There is however a dearth of information on the current data on milk production and pricing. According to Ngigi (2005), the bulk of Kenya's milk production probably never did flow through official channels, but the market share represented by these channels fell sharply after the sector was liberalized in 1992. Estimates

in the report by Behnke (2005) show that official recorded milk production now constitutes only about 5% of total national production. This means that a lot of milk goes unaccounted for. This is the same scenario with the households in Shinyalu, most of the respondents could not give an account of exactly how much milk they got per day, they claimed that there were variations in production hence it was difficult to quantify how much milk they got in total but they could only give estimates. Behnke (2005) further states that, milk production constitutes about 73% of the value of livestock's contribution to agricultural GDP, and milk from cattle is Kenya's single most valuable livestock product. This is similar to Shinyalu where milk is the most important product from livestock.

Contribution of on-farm tree planting to household income

The results of the study showed that 75.2% of the households earned a mean annual income of Kshs 105,616.55 from on-farm tree planting products. On-farm tree planting was the second highest source of household income in the study area. The responses obtained from the focus group discussions with the farmers showed that the major products that earned high incomes were timber, round poles and selling the whole tree. Other products included firewood, fruits, ropes, and, herbal medicine from the bark of the tree and roots. Products such as timber, round poles and the whole tree were sold once in a while when there is need while fruits, firewood, ropes and medicine were sold whenever they were available or in season. Firewood was the product that was used most for energy by majority of the households that were sampled. When converted to the amount of money that could have otherwise been utilized if an alternative source of energy was being used, the household would be spending at least Kshs 2000 per month for cooking gas and Kshs 3000 for charcoal. This money is diverted to other uses that are beneficial to the family. If trees were not available, this could not be case. The farmers also indicated that trees on-farm contribute indirectly to their overall production of crops through soil conservation, nitrogen fixing and soil fertility which improves and increases their yield. They can also be used as fodder for livestock and hence save the farmer the cost of having to buy livestock feed.

According to Miller (2016), trees on-farm account for an average of 17% of total annual gross income for tree-growing households and 6% for all rural households. This is very true in Shinyalu Sub-County where we have households that solely depend on selling trees in order to meet their urgent needs such as school fees. A study done in Southwest China by Weyerhaeuser and Kahrl (2006) found that trees planted on farms contributed more to

household income and conservation of ecosystem services than trees in forests. In Nepal, farmers have been intercropping trees with food crops on their farm land to maintain land productivity and to provide for subsistence household needs, including timber, fodder for livestock and firewood for cooking (Neupane et al., 2002). Arnold and Dewees (1995) agree with this study by stating that in farming areas, farmers maintain and plant trees that enhance food, fuel and medical security, especially for low-income rural people and during hungry periods, diversify income, lower production risk and optimize the management of resources. Similar results have been found by FAO (2004) that poverty could be alleviated by trees on farm by providing household income and food for poor farmers whose livelihoods are increasingly threatened by harsh environmental conditions and land degradation.

Other studies by Miller (2016) have shown that the contribution of trees on farms to household income is often left out of forest-related, agricultural and livelihood statistics and little remains known about their prevalence and economic contribution, particularly at the national level. Barton (2002) agrees with Miller (2016) by stating that, in forestry, the focus is mostly on trees in forests not those on farms. In agriculture and livelihood studies, the focus is always on annual crops and their effects on household income yet trees on farms are often a vital component of agriculture-forest landscapes. In a study done in Pakistan, Bukhari (1997) echoed these sentiments by stating that, though the contribution of on-farm tree planting to household income is recognized both in academic literature and in government policy, uptake is still lower than anticipated in many areas. This is because forestry research and education focuses mainly on technical forestry and its importance to households and leaves out trees on-farm. The concept of the importance of on-farm tree planting and its contribution to household income has not been enforced to an appreciable scale. This is the same scenario in the study area where, even though on-farm tree planting is the second highest source of household income, it has become difficult to quantify the amount of income earned by households because of the perception that has been formed about its importance. This reflects the TPB tenet on perceived behavioural control where the farmers' laxity towards quantifying how much on-farm tree planting earns the household is a function of their perception of the contribution of on-farm tree planting to household income.

According to Langat (2016), profitability analysis needs to be done when growing trees on-farm for commercial purposes. This is because tree growers should be able to compare profitability of various tree-based enterprises with competing land uses such as crop farming and other enterprises to enable them make best choices that meet their financial expectations.

His study proves that, growing Eucalyptus for power transmission poles can earn a farmer about a million Kenya Shillings per acre after eight years translating to net revenue of about Kshs 125,000 per year. This is more than income from maize growing in some areas. If farmers can be sensitized on the economic benefits of on-farm tree planting in comparison to other farming practices, then this would be an incentive for them to plant trees on their farms on large scale and as a result increase the tree cover on their farms to the required standard of 10%. Arnold and Dewees (1998) argue that strategies to encourage on-farm tree planting need to be based on an understanding of farmers' tree management in the context of their contribution to household income, pointing out that little is known about farmers' perceptions of the value of trees and about the constraints they face in developing tree resources.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of findings

5.1.1 Extent to which on-farm tree planting has been adopted

The study sought to assess the extent to which on-farm tree planting had been adopted in the area. The results of this study showed that woodlots (24%), trees on boundaries (23%) and scattered trees (21%) were the most common patterns and configurations in tree planting. It went further to assess the reasons for preference of these patterns and configurations. Woodlots were adopted mainly for timber and sale for income and had 297 (28%) responses. Trees on boundaries were adopted for land demarcation with 272 (25.6%) responses and scattered trees were adopted for firewood, shade, wind breaking, soil conservation and aesthetic value with 310 (29.2%) responses. Majority of the farmers preferred exotic tree species (Eucalyptus grandis, Croton macrostacheus, Cupressus lusitanica and Grevillea robusta) probably because of their high commercial value since they were managed mainly for timber, poles and fuel wood. Integration of these trees in croplands was, however, poor because of their negative effects on crops. The survival rate of seedlings was a bit low as a result of planting low quality seedlings that had weak stems and lost leaves prematurely. It is therefore evident that farmers had established woodlots, planted trees on the boundaries of their land and planted scattered trees for various purposes. Each household had also planted a variety of tree species on their land with Eucalyptus grandis coming up as the most important tree due to its good quality timber, fast growth and other factors. This shows that the people highly regard trees and that is why they have set aside land to plant them because of their economic value and the benefits they have. However, the survival rate of planted seedlings needs to be addressed because it is very low. The survival rate may pose a threat to afforestation whereby, when a farmer cuts down a tree and would like to replace it, if the planted tree does survive, the tree cover will automatically go down, and this will lead to eventual deforestation. This may discourage farmers from planting trees in future, a situation that will lead to serious environmental degradation.

5.1.2 Social factors influencing adoption of on-farm tree planting

The study determined the main social factors that influenced adoption of on-farm tree planting. The social factors that were ranked very important were: access to existing forest/ distance to the forest (94.0%), gender 72.7%, Land size (71.4%), education level (68.2%), and family size (63.5%). The least important factors were: Access to credit (35.9%), age of household head (35.7%), and, farm and off-farm income (34.9%). The land sizes varied with majority 258 (67.2%) of the respondents having land sizes of less than 2 acres, and very few 30 (7.8%) having 4.5acres and above. This land size was very small considering the various sub-divisions that had to be done on the land, the large household sizes that rely on the small piece of land and the high poverty rates that require optimum food production to feed the large families. This amounts to great pressure on the land hence difficulty in adopting on-farm tree planting. Households with family sizes of 10 members and above had the lowest mean number of trees planted on their farms. Those with smaller family sizes had the highest number of trees on their farms. Gender was an important factor because tree planting was perceived as a man's job. All the gender roles in tree establishment were allocated to men. The results of the study showed that husbands (men) were the main planters of trees (69.0%), they tended the trees (52.6%), and they decided when to harvest trees on the farm (67.0%). Education was a very important factor because the most educated people had more trees on their farms. The study showed that those with university education had a mean of 400 trees on their farms, college had 245.92, those with secondary education had 70.92, primary education had 30.77 and lastly those with no education had 20.50 on their farms. The results indicated that distance from the household to the forest was positively correlated to the number of trees planted on-farm in the study area. There were fewer trees planted (398.4) at a distance of less than 0.5 km from the house to the nearest forest edge and more trees (823.3) planted at a distance of 1.6-2.0 km further from the forest.

5.1.3 Contribution of on-farm tree planting to household income vis-a-vis other farming practices.

The study determined the other important farming practices in the area and why they were preferred over tree planting. The results of the analysis showed that apart from tree planting there were 3 other main farming practices in Shinyalu: Crop production, livestock rearing and beekeeping. Linking of these farming practices to the reasons for preference showed that the

most important farming practice was crop production with majority of the respondents 286 (74.5%), ranking it highly for food while 98 (25.5%) preferred it for income. The second most important practice was livestock keeping/dairy farming being highly ranked for income/sale 238 (70%), food 121 (31.5%) and manure 25 (6.5%). The least important farming practice was bee keeping which all the respondents who practiced it 23 (100%) did it for income generation. In terms of contribution to household income, it was observed that majority of the respondents (86.5%) had income from sale of crops from their farms. Crop farming gave a mean annual income of Kshs 140,847.14, from two seasons of harvesting in a year. The maize stalks and maize cobs were also used as animal feed and this ensured that the livestock were well fed and even increased the production of milk for dairy cattle. Crop farming was the highest household income earner in the area. The results of the study showed that 75.2% of the households earned a mean annual income of Kshs 105,616.55 from on-farm tree planting. The major products that had a high source of income were timber, round poles and selling the whole tree. On-farm tree planting was the second highest household income earner in the study area. Livestock farming had 62.2% of the respondents getting a mean annual income of Kshs 90,547.74 per year from the sale of dairy products while 52.9% of the respondents got a mean annual income of approximately Kshs 71,500.50 per year from the sale of livestock.

5.2 Conclusions

This study has shown that the extent to which on-farm tree planting has been adopted in an area determines the rate of deforestation. It is therefore a very important farming practice that should be taken up by small scale farmers in rural areas. The study found that the survival rate of planted tree seedlings was low as a result of poor quality seedlings. The conclusion made is that, survival of planted seedlings is key in ensuring the success of adoption of on-farm tree planting because if planted seedlings will not survive, then there will be no new trees coming up when a farmer has intensions of replacing the trees he will have harvested. This means that the extent of adoption of on-farm tree planting in Shinyalu was low.

The results of the study showed that there were both social factors that influenced adoption of on-farm tree planting and those that did not. Education level, gender, land size, family size and distance to the forest were the most important factors. The conclusion made is that, social factors determine the farmers' attitudes and perceptions towards on-farm tree planting and this makes them either take it up as an important farming practice or not take it up at all.

The study found that on-farm tree planting is the second highest source of household income in the area. However, most farmers were not completely aware of its contribution due to their preference of quicker ways of earning income i.e. crop farming. As a result most farmers look at it mainly as a source of firewood but not a farming practice that can earn them a reasonable amount of income for improvement of their livelihoods. The conclusion made is that, though on-farm tree planting is an important farming practice in the area, very little is known about its importance and this therefore calls for more sensitization and training of farmers on the benefits of adopting the practice.

5.3 Recommendations

It is recommended that, trainings and sensitization programmes for local farmers on the importance of on-farm tree planting, various on-farm tree planting technologies, propagation of seedlings, and nursery management practices for sustained production should be done by organizations dealing with forestry such as the Kenya Forestry Research Institute and the Kenya Forest Service. Institutional support through incentives such as subsidies to farmers who buy seedlings, technical support and creation of market opportunities should also be given in order to boost private investment in tree planting.

Land size was one of the major social factors influencing adoption of on-farm tree planting. Extension officers at the local government level should therefore assist farmers in farm planning through offering technical advice and dissemination of information to enhance optimal allocation of land to competing land uses. Studies that optimize tree-crop-soil interactions should also be undertaken as a mechanism for enhancing integration of trees into croplands including fruit trees and fast growing fodder tree species to improve livestock production. A model for diagnosing land use problems and for recommending appropriate interventions, and monitoring and evaluating impacts of tree planting should also be developed by forest related organizations.

The farmers in the area have inadequate knowledge on the contribution of on-farm tree planting to household income. Forestry research organizations should therefore look into capacity building of the farmers on economic valuation of various tree species so that they can be enlightened on the value of each species and the amount of money each can earn.

5.4 Areas for further research

The study suggests that more studies should be done on how Eucalyptus which has adverse effects on crop land and water bodies can be replaced with more environmentally friendly indigenous tree species.

REFERENCES

Affognon, H. D., Kingori, W. S., Omondi, A. I., Diiro, M. G., Muriithi, B. W., Makau, S., & Raina, S. K. (2015). Adoption of modern beekeeping and its impact on honey production in the former Mwingi District of Kenya: assessment using theory-based impact evaluation approach. *International Journal of Tropical Insect Science*, *35*(02), 96-102.

Ainembabazi, A. H., &Mugisha, J. (2014).The Role of Farming Experience on the Adoption Of Agricultural Technologies: Evidence from Smallholder Farmers in Uganda. *The Journal of Development Studies*, *50*(5), 666-679.

Ajayi, O. C., Franzel, S., Kuntashula, E., &Kwesiga, F. (2003). Adoption of improved fallow technology for soil fertility management in Zambia: Empirical studies and emerging issues. *Agroforestry Systems, 59*(3), 317- 326.

Ajayi, O. et al., (2006). Typology and characteristics of farmers planting improved fallows in Southern Africa. *Zambian Journal of Agricultural Sciences*, *8*(2), 1-5.

Ajayi, O.C., Akinnifesi, F.K., Sileshi, G., and Kanjipite, W. (2009). Labour inputs and Financial profitability of conventional and agroforestry-based soil fertility management practices in Zambia. *Agrekon, 48* (3), 276–292.

Ajayi, O.C., Akinnifesi, F.K., and Sileshi, G.W. (2011). Agricultural success from Africa: the case of fertilizer tree systems in southern Africa (Malawi, Tanzania, Mozambique, Zambia and Zimbabwe). *International Journal of Agricultural Sustainability, 9* (1), 129–136.

Ajzen, I. & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour.* Englewood Cliffs, NJ: Prentice Hall.

Ajzen, I. (1988). *Attitude, personality and behaviour.* Milton Keynes: Open University Press.

Ajzen, I. (1991). *The theory of planned behaviour. Organizational Behaviour and Human Decision Process* 50:179-211.

Ajzen, I. (2001). *Nature and operation of attitudes*. *Annual Review of Psychology* 52:27-58.

Akinnifesi, F.K. (2010). Fertilizer trees for sustainable food security in the maize-based production systems of East and Southern Africa. A review. *Agronomy for sustainable development, 30* (3), 615–629.

Alassaf, A., Majdalwai, M. and Nawash, O. (2011). Factors affecting farmer's decision to continue farm activity in marginal areas of Jordan. *African journal of agricultural research. Vol.6* (12). Pp. 2755-2760.

Amacher, G.S., Hyde, W.F. and Rafiq M. (1993). Local adoption of new forestry technologies: an example from Pakistan's northwest frontier province. *World Development 21* (3): 445–453.

Angelsen, A. & Wunder, S. (2003). Exploring the forest-poverty link: Key concepts, issues andresearch implications. *CIFOR Occasional Paper No. 40*. CIFOR, Bogor.

Anton, V., Hartley, S., Wittmer, H., (2015). Survival and growth of planted seedlings of three native tree species in urban forest restoration in Wellington, New Zealand. *New Zealand Journal of Ecology (2015) 39*(2): 170-178.

Arnold, J.E.M., Dewees, P.A. (1995). *Tree management in farmer strategies: responses to agricultural intensification.* Oxford University Press, London.

Arnold, J.E.M., Dewees, P.A. (1997). *Farms, trees and farmers: responses to agricultural intensification.* Earthscan Publications, London.

Arnold, J.E.M., Dewees, P.A. (1998). *Rethinking approaches to tree management by farmers. Natural Resource Perspectives 26.* London: Overseas Development Institute.

Arnold, M. (1997). Trees as out-grower crops for forest industries: Experience from the Philippines and South Africa. *Rural Development Forestry Network, Network Paper 22a (winter 1997/1998)*. ODI, London, United Kingdom. AgriculturaIntensification. Earthscan Publications, London.

Arnold, J.E.M. (2001). Forestry, poverty and aid. *CIFOR Occasional Paper No. 33.* CIFOR, Bogor, Indonesia.

Arnold, M. and Townson I. (1998). Assessing the potential of forest product activities to contribute to rural incomes in Africa. *Natural Resources Perspectives, No.37.* London, UK: Overseas Development Institute.

Asfaw, A., &Admassie, A. (2004). The role of education on the adoption of chemical fertilizer under different socioeconomic environments in Ethiopia. *Agricultural Economics, 30*(3), 215–228.

Atchia, M. and Tropp, S. (1995). *Environmental management: Issues and solutions*. UNEP, England.

Ayinde, O. E., Adewumi M. O., Olatunji G. B.,& Babalola O. A. (2010). Determinants of Adoption of Downy Mildew Resistant Maize by SmallScale Farmers in Kwara State, Nigeria. *Global Journal of Science Frontier Research, 10*.

Bailey, J.D., Tappeiner, J.C. (2007). Effects of thinning on structural development in 40–100 year-old Douglas-fir stands in western Oregon. *Forest Ecology and Management* 108, 99–113.

Bajracharya, G. (1983). *The Socio-Economic Effects of Forest Management on Lives of People Living in the Area. The Case of Central America and Some Caribbean Countries.* In: Hallsworth.

Barr, C., Resosudarmo, I.A.P., Dermawan A. and McCarthy, J. (2006). *Decentralization and forest administration in Indonesia: implications for forest sustainability, community livelihoods, and economic development.* CIFOR. Bogor, Indonesia.

Bee keeping. (2018). http://www.nafis.go.ke/livestock/bee-keeping.

Beedell, J. and Rehman T. (2000). Using social-psychology models to understand farmers' conservation behaviour. *Journal of Rural Studies* 16:117-127.

Behnke, R., Muthami, D. (2011). The Contribution of Livestock to the Kenyan Economy. IGAD Livestock Policy Initiative. *IGAD LPI Working Paper* No. 03 – 11.

Bekele-Tesemma, A., Birnie, A. & Tengnäs, B. (1993). Useful trees and shrubs for Ethiopia: identification, propagation and management for agricultural and pastoral communities. *Technical Handbook* No 5. Regional Soil Conservation Unit/SIDA, Nairobi, Kenya. 474 pp.

Bentley, J. W., E. Boa, and J. Stonehouse. (2004). Neighbor trees: shade, intercropping and Cacao in Equador. *Human Ecology* 32**:**241–270.

Bhagwat, S.A. (2008). Agroforestry: a refuge for tropical biodiversity? *Trends in ecology & evolution*, 23 (5), 261–267.

Biellik, R. J. and Henderson, P. L. (1981). Mortality, nutritional status and dietary conditions in a food-deficit region: North Teso district. *Uganda, Ecology and Food Nutrition, 11*, 163–170.

BIOTA. (2010). *Kakamega Forest Ecosystem Management Plan 2010-2020.*

Blaug, M. (1972). *Introduction to the Economics of Education*. Harmondsworth: Penguin.

Bonnard P., Scherr S. (1994). Within gender differences in tree management: Is gender distinction a reliable concept? *Agroforestry Systems 25*: 71–93.

Bordelon, B. (2018). *Trees have aesthetic value and improve property value*. http://urbanforestrynetwork.org/benefits/aesthetic.htm

Bradley, P.N. and Kuyper, J.B.H. (1985). *Woody biomass survey of Kakamega District*. Beijer Institute, Nairobi, Kenya (unpublished).

Brahmi, M. K., Thakur K.S. (2011). *Factors affecting people participation in Hariyaki Project under Nalagarh block of Himachal Pradesh.* 105-111.

Bukhari, A.S. (1997). *The role of NGOs in promoting fuel wood production in Pakistan. In: National workshop on wood fuel production and marketing in Pakistan.* RWEDP Report no.49. Faisalabad, Pakistan: FAO Regional Wood Energy Development Programme in Asia (GCP/RAS/154/NET).

Buyinza, M. (2008). Financial efficiency of improved fallow agroforestry technology for bean production in Kakoge Sub-county, Nakasongora District, Uganda. *Nepalese Journal of Development and Rural Studies*, *4*(2), 68–69.

Buyinza, M. (2009). Land use intensity in tree cropping homesteads in Kamuli, Eastern Uganda. *Agricultural Journal*, *4*(2), 46–51.

Byron, N. (2001). Keys to smallholder forestry. *Forests, Trees and Livelihoods* 11(4): 279–294.

Caldwell, J.C. (1977). "The economic rationality of high fertility: an investigation illustrated with Nigerian data." *Population Studies* 31(1): 5-27.

Campbell, B. M. (1986). The importance of wild fruits for peasants households in Zimbabwe. *Food and Nutrition*, *12*(1), 38–44.

Carnea, M.M. (1992). *A Sociological framework: policy, environment and the social actors of tree planting.* In: Sharma, N.P. (ed.) (1992). Kendal/Hunt Publishing Company. Iowa. Pp. 301–335.

Carroll, T., & Kinsella, J. (2013). Livelihood improvement and smallholder beekeeping in Kenya: the unrealised potential. *Development in Practice*, 23(3), 332-345.

Carsan, S. and Holding, C. (2006). Growing farm timber: practices, markets and policies. *The Meru timber marketing pilot programme case studies and reviews*. World Agroforestry Centre.

Chamshama, S.A.O. (2011). *Forest plantations and woodlots in the eastern and north eastern African countries.* African Forest Forum.

Cheboiwo, J. (2012). Modelling cost efficient marketing framework for linking small scale eucalyptus growers to transmission pole treatment plants in Western Kenya. *Concept for farm forestry 2012/2013.*

Cheboiwo, J.K. (2017). *Socioeconomic factors influencing farm forestry investment decisions in Kenya: The case of Uasin gishu and Vihiga Counties*.

Cochrane, N. and D'Souza, A. (2015). *Measuring Access to Food in Tanzania: A Food Basket Approach.* United States Department of Agriculture Economic Information Bulletin. No. 135. https://www.humanium.org/en/convention/

Coomes, O.T. and Barham, B.L. (1997). Rain forest extraction and conservation in Amazonia. *The Geographical Journal* 163(2): 180-188.

Current, D., Lutz, E. and Scherr, S. (1995). Costs, benefits, and farmer adoption of agroforestry. *World Bank Environment Paper, No. 14.* The World Bank, Washington, DC.

Dahlquist, R. (2007). *Incorporating livelihoods in biodiversity conservation: a case study of cacao agroforestry systems in Talamanca, Costa Rica*. Biodiversity and conservation, 16 (8), 2311–2333.

Daigle, J.J., Hrubes, D. and Ajzen, I. (2002). *A comparative study of beliefs, attitudes, and values among hunters, wildlife viewers, and other outdoor recreationists.* Human Dimensions of Wildlife 7:1-19.

De Foresta H, Somarriba E, Temu A, Boulanger D, Feuilly H, Gauthier M. 2013. *Towards the assessment of trees outside forests*. Resources Assessment Working Paper 183. Rome: Food and Agriculture Organization of the United Nations. http://www.fao.org/docrep/017/aq071e/aq071e00.pdf. Accessed 4 March 2014.

De Waal, A. (1989). *Famine that kills: Darfur, Sudan 1984–1985*. Oxford, UK: Clarendon Press.

Dei, G. (1992). *A Ghanaian rural community: Indigenous responses to seasonal food supply cycles and the socio-economic stresses of the 1980s.* London: Routledge, pp. 58–81.

Dewees, P. A. (1991). Social and Economic Incentives for Smallholder Tree Growing. A case Study from Murang'a District, Kenya. *Forests, Trees, and People/FAO. Community Forestry Case Study Series No.5.*

Dewees, P. A. (1993). Trees, Land and Labour. *Environment Department Paper No. 4.* Washington, D.C.: World Bank.

Dewees, P. (1995). Trees and Farm Boundaries: Farm Forestry, Land Tenure and Reform in Kenya. Africa. 65. 10.2307/1161191.

Dewees, P.A. and Saxena, N.C. (1997). Tree planting and household land and labour allocation: case studies from Kenya and India. In: Arnold, J.E.M. and Dewees, P.A.eds. *Farms, trees and farmers: responses to agricultural intensification.* Earthscan, London. p. 242–267.

Dobie, P., Sharma, N. (2014). Trees as a global source of energy: from fuelwood and charcoal to pyrolysis-driven electricity generation and biofuels. *Abstract: World Agroforestry Congress-2014, New Delhi*

Dolisca, F., McDaniel, J. M., Teeter, L. D. and Jolly, C. M. (2007). "Land tenure, population pressure, and deforestation in Haiti: the case of Forˆet des Pins Reserve," *Journal of Forest Economics*, vol. 13, no. 4, pp. 277–289.

Dorrough, J., and C. Moxham. (2005). Eucalypt establishment in agricultural landscapes and implications for landscape-scale restoration. *Biological Conservation* 123**:**55–66.

Douglas, G., Dodd, M., Power, I. (2007). Potential of direct seeding for establishing native plants into pastoral land in New Zealand. *New Zealand Journal of Ecology 31: 143–153.*

Dudovskiy, J. (2018). The Ultimate Guide to Writing a Dissertation.

Duguma LA, Hager H (2010). *Woody plants diversity and possession, and their future prospects in small-scale tree and shrub growing in agricultural landscapes in Central High-lands of Ethiopia.* Small Scale 9:153–174.

Edinam K. G., Hassan B. A., & Mawutor K. G. (2013) Analysis of Socio-Economic Conditions Influencing Adoption of Agroforestry Practices. *International Journal of Agriculture and Forestry,* 3(4): 178-184.

Enters, T., Durst, P.B., Brown, C., Carle, J. and Mckenzie, P. (2004). What does it take? The role of incentives in forest plantation development in Asia and the Pacific. *Asia-Pacific Forestry Commission, Regional Office for Asia and the Pacific*, FAO, Bangkok.

Ertiro, H. (2006). *Adoption of physical soil and water conservation structures in Anna Watershed, Hadiya Zone, Ethiopia.* [M.A. Thesis Regional and Local Development, School of Graduate Studies, University of Addis Ababa].

Evans, J. (1992). Plantation forestry in the tropics. *Tree planting for industrial, social, environmental and agroforestry purposes.* 2nd edition. Clarendon Press. Oxford. 403p.

Factors largely contributing to unemployment in Kenya. (2015). http://thesankale.blogspot.com/2015/07/factors-largely-contributing-to.html.

FAO. (1986). *Tree growing by rural people.* Rome: Food and Agriculture Organization of the United Nations.

FAO. (1993). *The challenge of sustainable forest management. What future for the world's forests?* Rome: Food and Agriculture Organization of the United Nations.

FAO. (2001). FAOSTAT Database Results 2001. http://apps.fao.org

FAO. (2009b). *Planted forests and second-generation biofuels.* Planted Forests and Trees Working Paper 42E. Forest Resources Development Service. FAO. Rome, Italy. 33pp.

FAO (2006). *Global Forest Resources Assessment 2005 –Progress towards sustainable forest management.* FAO Forestry Paper 147: Rome, FAO.

FAO. (2010). *The state of food insecurity in the world.* Rome: Food and Agriculture Organization of the United Nations.

FAO/REOSA. (2010). *Farming for the future in Southern Africa: An introduction to conservation agriculture.* (FAO Regional Emergency Office for Southern Africa) REOSA Technical Brief No. 1.

FAO. (2014). State of the World's Forests report (SOFO).

FAO. (2015). *Global Forest Resources Assessment.* Rome: Food and Agriculture Organization of the United Nations.

Feder, G., Just, R.E. and Zilberman, D. (1985). *Adoption of agricultural innovation in developing countries: a survey.* Economic Development and Cultural Change 33: 255-298.

Fern, K. (2014). Useful Tropical Plants Database. http://tropical.theferns.info/viewtropical.php?id=Cupressus+lusitanica

Fischer, J. Lindenmayer, D. (2007). *Landscape modification and habitat fragmentation. A synthesis.* Global ecology and biogeography 16 (3), 265-280.

Fishbein, M. and Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research.*

Fobissie, B. (2010). Tree Knowledge and Livelihood Activities in a Changing Environment: Views from smallholder farmers in Kosti, Sudan. *Journal of Sustainable Forestry* 29:6-8, 591-612, DOI:10.1080/10549811003742084.

Garforth, C., Rehman, T., McKemey, K., Tranter, R.B., Cooke, R.J., Yates, C.M., Park, J.R. and Doward, P.T. (2004). Improving the design of knowledge transfer strategies by

understanding farmer attitudes and behaviour. *Journal of Farm Management* 12:17-32.

Garrity, D.P. (2010). *Evergreen agriculture: a robust approach to sustainable food security in Africa.* Food security, 2, 1–18.

Garrity, D. and Stapleton, P. (2011). *More trees on farms.* Trees and farming, 2, 8-9.

Gibbons, P., and M. Boak. (2002). *The value of paddock trees for regional conservation in an agricultural landscape.* Ecological Management and Restoration 3**:**205–210.

Gibbons, P., Lindenmayer, D. B., Fischer, J., Manning, A. D., Weinberg, A., Seddon, J., Barrett, G. (2008). *The future of scattered trees in agricultural landscapes.* Conservation Biology, 22, 1309–1319.

Githiomi JK, Mugendi DN, Kung'u JB (2012). Analysis of household energy sources and woodfuel utilisation technologies in Kiambu, Thika and Maragwa Districts of Central Kenya. *Journal of Horticulture and Forestry.* 4(2): 43-48.

Global Environment Facility. (2005). *What Kind of World? The Challenge of Land Degradation.* Washington, D.C. U.S.A.

Government of the Republic of Kenya, (2007). Ministry of Environment and Natural resources, *sessional paper no. 1 of 2007 On Forest Policy*.

Government of the Republic of Kenya, (2008). Kenya Vision 2030 Sector Plan For Environment, Water and Sanitation 2008–2012, Government Printers, Nairobi, Kenya.

Government of Kenya. (2009). *National beekeeping policy* [proposed]. Nairobi: Ministry of Livestock, Government of the Republic of Kenya.

Graham, S., Filmer, M. (2007). *Survey sheds light on sapling survival*. Farming Ahead 187: 56–59.

Greene, W.H. (1995). *Reference Guide*. Econometric Software Inc. New York: Bellport.

Haglund, E., Ndjunga, J., Snook, L., Pasternak, D. (2011). *Dry land tree management for improved household livelihoods: Farmer managed natural regeneration in Niger*. 92:1696–1705.

Haltia, O. & Keipi, K. (1999). Financing forest investment: The issue of incentives. *Forest resource policy in Latin America.* Inter-American Development Bank. Washington, D.C., 63-78 pp.

Ham, C. (2018). Importance of woodlots to local communities, small scale entrepreneurs and indigenous forest conservation – A case study.

Harvey, C. A., and W. A. Haber. (1999). *Remnant trees and the conservation of biodiversity in Costa Rican pastures.* Agroforestry Systems 44**:**37–68.

Hassan R, Scholes R, and Ash N (eds) 2005. *Ecosystems and Human Well-being: Current State and Trends.* Volume 1. Island Press, Washington.

Heong, K. L. and Escalada, M.M. (1999). *Quantifying rice farmers' pest management decisions: Beliefs and subjective norms in stem borer control*. Crop Protection 18:15-322.

Heslop, T.G., (1999). *The ageing and development report: Poverty independence and the world's older people.* London, England. Earthscan Publications Limited.

Hilmi, M.,Bradbear, N., Mejia, D.(2011). *Bee keeping and sustainable livelihoods.* Diversification booklet number 1. Second edition. Food and Agriculture Organization of the United Nations.

Holden, S., S. Benin, B. Shiferaw, and J. Pender. (2003). *Tree planting for poverty reduction in less-favored areas of the Ethiopian highlands.* Small-scale forest economics, management and policy2 (1): 63–80.

Holzwarth F., Kahl A., Bauhus J., Wirth C. (2013). Many ways to die – partitioning tree mortality dynamics in a near-natural mixed deciduous forest. *Journal of Ecology 101: 220–230.*

Hossain M. (1988). *Credit for alleviation of rural poverty: The Grameen Bank in Bangladesh (Research Report N° 65).* International Food Policy Research Institute: Washington DC, USA.

Hyman, E.L. (1983). *Loan financing of smallholder tree farming in the provinces of Ilocos Norte and Ilocos Sur, the Philippines*. Agroforestry Systems 1 (3): 225–243.

International Centre for Research in Agro forestry. (1992). A Selection of Useful Trees and Shrubs for Kenya. ICRAF, Nairobi, Kenya.

Jacovelli, P. and Caevalho, J. (1999). The private forest sector in Uganda - Opportunities for greater involvement. Kampala, Uganda: Ministry of Water, Lands and Environment.

Jagger, P., and J. Pender. (2003). *The role of trees for sustainable management of less-favored lands: the case of eucalyptus in Ethiopia*. Forest policy and economics 5(1): 83–95.

Jagger, P., Pender, J., & Gebremedhin, B. (2005). *Trading Off Environmental Sustainability for Empowerment and Income: Woodlot Devolution in Northern Ethiopia.* World Development, 33(9), 1491-1510. (http://dx.doi.org/10.1016/j.worlddev.2004.10.010)

Jalota, R. K., & Sangha, K. K. (2000). *Comparative ecological-economic analysis of growth performance of exotic Eucalyptus tereticornis and indigenous Dalbergia sissoo in mono-culture plantations.* Ecological Economics, 33(3), 487-495. (http://dx.doi.org/10.1016/S0921-8009 (00)00133-6)

Jamala, G. Y., Shehu, H. E., Yidau, J. J., & Joel, L. (2013). *Factors Influencing Adoption of Agro-Forestry among Smallholder Farmers in Toungo, Southeastern, Adamawa State, Nigeria.IOSR Journal Of Environmental Science, Toxicology And Food Technology* (IOSR-JESTFT) e-ISSN: 2319-2402,p- ISSN: 2319-2399. Volume 6,Issue 6 (Nov. – Dec. 2013), PP 66-72 www.iosrjournals.org

Javier-German, R., David, M., María-Jesus A., Petri K., Mario, E. (2011). Avocado (Persea Americana Mill.) Phenolics, in Vitro Antioxidant and Antimicrobial Activities, and inhibition of lipid and protein oxidation in porcine patties. *Journal of agriculture and food chemistry 59, 562–5635.*

Jayne, T.S., Yamano, T., Weber, M., Tschirley, D., Benfica, R., Neven, D., Chapoto, A., Zulu, B., 2003. *Smallholder Income and Land Distribution in Africa: Implications for Poverty Reduction Strategies.* International Development Paper 24, Department of Agricultural Economics, MSU, East Lansing.

Jemmott, L.S. and O'Leary, A. (1992). Reduction in HIV risk – associated sexual behaviors among black male adolescents: effects of an AIDS prevention and intervention. *American journal of public health 82 (3), 372-377.*

Jones, P.G. and Thornton, P.K. (2003). *The potential impacts of climate change on maize production in Africa and Latin America in 2055*. Global environmental change, 13 (1), 51–59.

Jose, S. (2009). *Agroforestry for ecosystem services and environmental benefits: an overview.* Agroforestry systems, 76 (1), 1–10.

Justin, W. (2014). *Fodder Banks: Investing in Resilience.* https://clasberkeley.wordpress.com/2014/01/21/fodder-banks-investing-in-resilience/

Kahuria, C. (2017). *Farmers reap benefits from woodlot establishment*. Kenya Forest Service.

Kaimowitz, D. (2003). Not by bread along, Forest and Rural livelihoods in Sub-Saharan Africa. *Forests in poverty reduction strategies capturing the potential*. *EFI proceedings No.47: 45-64*. European Forest Institute, Finland.

Kakuru, O.V., Doreen, M. and Wilson, M. (2014). Adoption of On-Farm Tree Planting in Kibaale District, Western Uganda. *Journal of Sustainable Forestry*, 33:1, 87-98, DOI: 10.1080/10549811.2013.776965

Kamuanga, M., Tano, K., Pokou, K., Jabbar, M., Swallow, B. (1999). *Farmers' preferences of cattle breeds, their market values and prospects for improvement in West Africa: a summary review.* Publication No 120, Stockwatch Ltd, Nairobi, Kenya. Pp.271-298

Kenya Forestry Research Institute, (2008). *Kenya Forestry Research Institute Strategic Plan 2008–2012*. Nairobi, Kenya.

Kenya National Bureau of Statistics (KNBS). (2010). *2009 Kenya Population and Housing Census. Vol.1A*. Ministry of Planning and National Development, Nairobi, Kenya.

Kidanu, S. (2004). *Using Eucalyptus for soil and water conservation on the highland vertisols of Ethiopia* [PhD dissertation. Department of Environmental Sciences, Wageningen University].

Kihiyo, V.B.M.S. (1996). Economic Evaluation of Rural Woodlots in a Developing Country: Tanzania. *Journal of Environmental Management*, *46*(3), 271–279. (http://dx.doi.org/10.1006/jema.1996.0021)

Kinuthia, K. (2018). School dropouts fuel inequality among children in Kenya. https://www.businessdailyafrica.com/datahub/School-dropouts-fuel-inequality-among-children-in-Kenya/3815418-4612552-vji9cmz/index.html.

Kiptot, E. (2007). *Adopters, testers or pseudo-adopters? Dynamics of the use of improved tree fallows by farmers in western Kenya.* Agricultural systems, 94 (2), 509–519.

Knabe, P.A. (2012). *Applying Ajzen's theory of planned behavior to a study of online course adoption in public relations education.* [PhD Thesis. Marquette University, Milwaukee, USA].

KNBS (2010). *Economic Survey 2010*. Kenya National Bureau of Statistics, Nairobi.

Koirala, K., Mishra, A., Mohanty, S. (2015). The role of gender in agricultural productivity in the Philippines: The average treatment effect.

Komblum, E. (2001). Marriage and Divorce. *Sociology in a Changing World*. Oriando: Harcourt Brace and Company.

Kothari, C.K. (2004). *Research Methodology: Methods and Techniques.* New Age Publishers, New Delhi, India.

Kulkarni GN, Bhatta R and Kumar NK. (1989). Integrated rural development programme in Bijapur: an evaluation of dairy scheme. *Social Change (India)* 5: 72-79.

Kumar, A., Sinha, A.K. and Singh, D. (2003). Studies of Eucalyptus plantations under the farm forestry and agroforestry systems of U.P. in Northern India. *Forests, Trees, and Livelihoods* 13:313–330.

Kung'u, J. Kihara, J. Mugendi, N and Jaenicke, H (2008). *Effect of small-scale farmers' tree nursery growing medium on agroforestry tree seedlings' quality in Mt. Kenya region*. Kenyatta University, World Agroforestry Centre (ICRAF).

Kuria, D. (2013). *Influence of extension approaches on on-farm tree planting: a case of farmer field schools in Mbeere District, Embu County, Kenya. [Master's Thesis*. University of Nairobi].

Landell-Mills, N.and Porras, I.T. (2002). Silver bullet or fools' gold? *A global review of markets for forest environmental services and their impact on the poor.* London, UK: IIED.

Layton, R., MacPhail, F. (2013). *Gender equality in the labor market in the Philippines.* Mandaluyong City, Philippines: Asian Development Bank. ISBN 978-92-9254-403-4 www.adb.org/publications/gender-equality-labor-market-philippines.

Leakey, R.R.B. and Tchoundjeu, Z. (2001). *Diversification of tree crops: Domestication of companion crops for poverty reduction and environmental services*. Experimental Agriculture 37 (3): 279– 296.

Lengkeek, AG. Kindt, R. Maesen, LJG. Simons, AJ. and Oijen, DCC. (2005). *Tree density and germplasm source in agroforestry ecosystems of Meru, Mount Kenya.* Genetic Resources and Crop Evolution 52: 709–721.

Libois, F. (2014). *Fertility, household's size and poverty in Nepal.* CHR Michelsen Institute.

Lionberger, H.F. (1960). *Adoption of New Ideas and Practices*. The Iowa State University Press, Ames.

Ludeki, J.V. Wamukoya, G.M. and Walubengo, D. (2004). Environmental Management in Kenya: A Guide to the Draft Forest Policy. Forest Action Network, Nairobi, Kenya.

Lumsden, L. F., and A. F. Bennett. (2005). *Scattered trees in rural landscapes: foraging habitat for insectivorous bats in south-eastern Australia*. Biological Conservation 122**:**205–222.

Lwayo, M. K. and Maritim, H. K. (2003). *Socio-economic factors affecting farmers' decision to adopt farm forestry; an application of multivariate logistic analysis in Busia district, Kenya.* 0096-B1

Lynam, J. &Hassan, R. M. (1998). *A New approach to securing sustained growth in Kenya's maize sector*. Wallingford, UK, CAB International.

Macoux, B.C. and Shope, J. T. (1997). *Application of the theory of planned behavior to adolescent use and misuse of alcohol.* Oxford university press, pp. 323-331.

Mahapatra, A.K. and Mitchell, C.P. (2001). *Classifying tree planters and non-planters in a subsistence farming system using a discriminant analytical approach.* Agroforestry Systems 52 (1): 41–52.

Mara, A. (2014). *Motherhood and Work: 'Why do more women than men stay at home with children?'* http://www.thejournal.ie/readme/why-do-more-women-than-men-stay-at-home-with-children-1608613-Aug2014/

Mantel, S., Van, E. (1994). *The impact of land degradation on food productivity. Case studies of Uruguay, Argentina and Kenya,* Volume 1: main report.

Manurung, G.E.S., Roshetoko, J.M., Budidarsono, S. and Kurniawan, I. (2008). Dudukuhan Tree farming Systems in West Java: How to mobilize Self-Strengthening of Community-Based Forest Management? *Smallholder Tree Growing for Rural Development and Environmental Services. Lessons from Asia*. Springer 2008.

Mariara, J.K. and Gachoki, C. (2008). *Forest dependence and household welfare: Empirical evidence from Kenya,* CEEPA Discussion Paper No. 41, CEEPA Discussion Paper Series.

Masangano, C. (1996). *Diffusion of agroforestry technologies.* http:// msu.edu/user/masangn/agrof.html

Maundu, P. & Tengnäs, B. (2005). *Useful trees and shrubs for Kenya*. World Agroforestry Centre - East and Central Africa Regional Programme (ICRAF-ECA), Technical Handbook 35, Nairobi, Kenya. 484 pp.

Michon, G. and De Foresta, H. (1997). Agroforests: pre-domestication of forest trees or true domestication of forest ecosystems? *Netherlands Journal of Agricultural Science* 45: 451–462.

Meijer, S. et al. (2015). Tree planting by smallholder farmers in Malawi: using the theory of planned behavior to examine the relationship between attitudes and behavior. *Journal of Tree planting.*

Mekonnen, A. (1998). *Rural Energy and Afforestation: Case Studies from Ethiopia.* [PhD thesis, Department of Economics, Gothenberg University, Sweden].

Miller, D.C., Juan-Carlos M., Luc, C. (2016) *Prevalence, economic contribution, and determinants of trees on farms across Sub-Saharan Africa*. Forest Policy and Economics, 2017; DOI: 10.1016/j.forpol.2016.12.005

Ministry of Environment Water and Natural resources (2014), Forest Policy 2014.

Ministry of Environment and Forestry (2018). Forest resources management and logging activities in Kenya.

Moraa, O. (2017). *Kenya: Women try beekeeping for safe, steady income during drought and conflict.* http://wire.farmradio.fm/en/farmer-stories/2017/09/kenya-women-try-beekeeping-for-safe-steady-income-during-drought-and-conflict-trust-16642

Moustakas, A., Evans R. M. (2015). Effects of growth rate, size, and light availability on tree survival across life stages: a demographic analysis accounting for missing values and small sample sizes.

Mtaki, B. (2016). *2016 Tanzania Corn, Wheat and Rice Report*. United States Development Agency.

Mugenda, O. and Mugenda, A. (1999). *Research methods quantitative and qualitative approaches.* African Center for Technology Studies (ACTS). Nairobi, Kenya.

Mugonola, B., Deckers , J., Poesen , J., Isabirye, M., &Mathijs, E. (2013). Adoption of soil and water conservation technologies in the Rwizi catchment of southwestern *Uganda. International Journal of Agricultural Sustainability*, 11(3), 264-281.

Muhammad, I., Khan, A., Mitsuhiro, M. (2011). Identifying factors affecting agroforestry system in Swat, Pakistan. *African Journal of Agricultural Resources* 6(11):2586–2593.

Muhihi, et al., (2012). *Perceptions, Facilitators, and Barriers to Consumption of Whole Grain Staple Foods among Overweight and Obese Tanzanian Adults: A Focus Group Study.* International Scholarly Research Network. Volume 2012, pp 7.

Mwakatobe, A., Mlingwa, C. (2005). *Tanzania - The status of Tanzanian honey trade: domestic and international markets.* Bees for Development Honey Trade Workshop, Dublin, Ireland, August 2005.

Nabangao, G. N. and Gombya-Sembajjwe, W. S. (2001). *The effect of household endowments and entitlements of natural forests.* International Forestry Review, *3*(1), 34–41.

Naidu, V. J. (1992). Planning and people participation in India. 22-23.

Nair, P.K.R., Kumar, B.M., and Nair, V.D., (2009). Agroforestry as a strategy for carbon sequestration. *Journal of plant nutrition and soil science*, 172 (1), 10–23.

Nambiar, E.K.S (ed.). (2008). *Site Management and Productivity in Tropical Plantation Forests.* Proceedings of Workshop in Piracicaba (Brazil) 22-26 November 2004 and Bogor (Indonesia) 6-9 November 2006. CIFOR, Bogor.

National Environment Management Authority. (2004). *State of Environment Report*. NEMA, Kenya.

Naturet (2018). *Trees, Boundaries and Highways*. http://naturenet.net/trees/boundaries.htm

Nawaz, Muhammad & Gul, S & Farooq, Taimoor & T. Siddiqui, M & Asif, M & Ahmad, Irfan & Niazi, Nabeel. (2016). Assessing the Actual Status and Farmer's Attitude towards Agroforestry in Chiniot, Pakistan. *International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering.* 10. 393-397.

Nawir, A.A. and Santoso, L. (2005). *Mutually beneficial company-community partnerships in plantation development: emerging lessons from Indonesia*. International Forestry Review **7** (3): 177–192.

NEPAD. (2003). Action Plan for the Environment Initiative. New Partnership for Africa's Development, Midrand, South Africa.

Ndayambaje, J.D., Heijman, W.J.M. & Mohren, G.M.J. (2012). *Small-scale Forestry* 11:477.doi: 10.1007/s11842-012-9196-0

Neupane, R.P., Sharma, K.R., Thapa, G.B. (2002) *Adoption of agroforestry in the hills of Nepal: a logistic regression analysis.* Agric Syst 72:177–196.

Ngigi, M. (2005). *The Case of Smallholder Dairying in Eastern Africa.* EPT Discussion Paper 131. International Food Policy Research Institute. Washington, D.C.

Ngurumwa, P. (2016). *Contribution of smallholder maize production towards household food security in Babati District.* [Masters dissertation. Mzumbe University, Tanzania.]

Nibbering, J.W. (1999). *Tree planting on deforested farmlands, Sewu Hills, Java, Indonesia: impact of economic and institutional changes.* Agroforestry Systems 46(1): 65–82.

Nightingale, J., & Crane, E. (1983). Lifetime's recollections of Kenya tribal beekeeping. International Bee Research Association.

Norland, E. (2011). Small Farms and Woodlots. USA: National Institute of Food and Agriculture.

Nyaranga, R. (2012). *Factors contributing to primary school pupils dropout in Bunyala District.* [Unpublished MSC project. University of Nairobi, Nairobi, Kenya].

O. V. Kakuru, M. Doreen & M. Wilson (2014). Adoption of On-Farm Tree Planting in Kibaale District, Western Uganda. *Journal of Sustainable Forestry*, 33:1, 8798, DOI:10.1080/10549811.2013.776965

Obiani, A.L. (2014). *Social indicators and effects of marriage divorce in African societies. Nigeria.* Department of Political Science and Strategic Studies Federal University Otuoke, Bayelsa State, Nigeria.

Oeba, O.V., Otor, C.J.S., Kung'u, B.J., Muchiri, M.N. (2012). *Modeling determinants of tree planting and retention on farm for improvement of forest cover in Central Kenya.* ISRN Forestry. Volume 2012 (2012), Article ID 867249, 14 pages. http://dx.doi.org/10.5402/2012/867249

Okango, M. (2015). Household gender roles and ' adoption of agroforestry among small scale farmers in Kwanza division, Trans nzoia district. Kenya. Rural Sociology and Community Development. [Masters project, Department of Sociology. University of Nairobi].

Oli, Bishwa & Treue, Thorsten & Larsen, Helle. (2015). *Socio-economic determinants of growing trees on farms in the middle hills of Nepal*. Agroforestry Systems. 89. 10.1007/s10457-015-9810-1.

Omuregbee, F. E. (1998). *Communication of improved farm practices to rural women farmers in Benue State, Nigeria.* Outlook on Agriculture, *27*, 53–56.

Opara U. K. (2013). Perspective: The Evolving Dimensions and Perspectives On Food Security – What Are the Implications for Postharvest Technology Research, Policy and Practice? *International Journal Postharvest Technology and Innovation. Vol. 3. No. 3.*

Orwa C., Mutua A., Kindt R., Jamnadass R., Anthony S. (2009). Agroforestry Database: *a tree reference and selection guide version 4.0.* http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp

Patrick O., R., Atieno (2006). *Agricultural Policy in Kenya: Issues and Processes.* A paper for the Future Agricultures Consortium workshop, Institute of Development Studies.

Pattanayak, S. K., Mercer, D. E., Sills, E., & Yang, J. C. (2003). *Taking stock of agroforestry adoption studies.* Agroforestry Systems 57(3): 137-150.

Pieters, H., Vandeplas, A., Guariso, A., Francken, N., Sarris, A., et al., (2012). *Perspectives on Relevant Concepts Related to Food and Nutrition Security.* Working Paper 1.

Plieninger, T., F. J. Pulido, and H. Schaich. (2004). Effects of land-use and landscape structure on holm oak recruitment and regeneration at farm level in Quercus ilex L. dehesas. *Journal of Arid Environments 57**:**345–364.*

Prevedello, (2017). The importance of scattered trees for biodiversity conservation: A global meta-analysis. https://doi.org/10.1111/1365-2664.12943

Quisumbing, A., Meinzen-Dick, R., Raney, T., L., Croppenstedt, A., Behrman, J. A., & Peterman, A. (2014). Closing the knowledge gap on gender in agriculture. *Gender in Agriculture* (pp. 3-27). Springer, Netherlands.

Rahmato, D. (1988). Peasant survival strategies in Ethiopia. *Disasters*, *12*, 326–44.

Raintree, J.B. (1983), *'Strategies for enhancing the adoptability of agroforestry innovation'*, Agroforestry Systems, 1: 173-187.

Ravindran, D.S. and Thomas, T.H. (2000). Trees on farms, stores of wealth and rural livelihoods - insights and evidence from Karnataka, India. *International Forestry Review* 2 (3): 182–190.

Randolph, S.L., Sanders, R. (1992). *Female farmers in the Rwandan farming systems: a study of the Ruhengeri Prefecture*. Agric Hum Values 9(1):59–66

Republic of Kenya (2005). *Economic Survey 2005*. Government Printer, Nairobi.

Republic of Kenya (2002). *National Development Plan 2002–2008.* Nairobi Government Printer

Richards, M., Maharjan, M., Keshav, K., (2003). Economics, Poverty and Transparency: Measuring Equity in Forest User-groups. *Journal of Forestry and Livelihood.*

Robertson, M., Nichols, P., Horwitz, P., Bradby, K. and Mackintosh, D. (2000). *Environmental narratives and the need for multipurpose perspectives to restore degraded landscape in Australia.* Ecosystem Health, *6*(2), 119–133.

Rochelau, D. (1991). *Gender, ecology and the science of survival: Stories and lessons from Kenya.* Agriculture and Human Values, *8*(1), 156–165.

Rocheleau, D. and Edmunds, D. (1997). "*Women, men and trees: gender, power and property in forest and agrarian landscapes,"* World Development, vol. 25, no. 8, pp. 1351–1371.

Rogers, E.M. (1984). *Diffusion of Innovations.* The Free Press, New York.

Rogers, E.M. (1995), *Diffusion of Innovations* (Fourth Edition), The Free Press, New York.

Rotich, B. & Chepkemboi, M. (2017). Status of Farm Forestry in Tarakwa Location, Uasin Gishu County, Kenya.

Salam, M.A., Noguchi, T. and Koike, M. (2000). *Understanding why farmers plant trees in the homestead agroforestry in Bangladesh.* Agroforestry Systems 50(1): 77–93.

Sale, F.A., Olujobi, O.O.J. (2014). Farmers perception of opportunities preferences and obstacles of growing multipurpose trees on farmland in Kogi State. *European Scientific Journal* edition vol.10, No.14 ISSN: 1857 – 7881 (Print) e - ISSN 1857-7431.

Sanchez, P.A. (1999). *Improved fallows come of age in the tropics*. Agroforestry systems, 47 (1–3), 3–12.

Sanchez, P.A. (2002). *Ecology: soil fertility and hunger in Africa*. Science, 295 (5562), 2019 2020.

Sanchez, P.A. and Swaminathan, M.S. (2005). *Cutting world hunger in half.* Science, 307 (5708), 357–359.

Sansoucy, R. (1995). *The contribution of livestock to food security and sustainable development.* Keynote paper.

Saxena, N.C. (1992). Adoption of a Long-Gestation Crop: Eucalyptus Growers in North-West India. *Journal of Agricultural Economics*, Vol.43.

Scherr, S.J. (1995). "*Economic factors in farmer adoption of agroforestry: patterns observed in Western Kenya,"* World Development, vol. 23, no. 5, pp. 787–804.

Scherr, S.J. (1997). Meeting household needs: farmer tree-growing strategies in western Kenya. *Farms, trees and farmers: responses to agricultural intensification.* Earthscan, London. Pp. 141–169.

Scherr, S.J. (2004). *Building opportunities for small-farm agroforestry to supply domestic wood markets in developing countries.* Agroforestry Systems 61–62(1): 357–370.

Sen, D. and Das, P.K. (1988). Poverty Alleviation through Group Farm Forestry – a Case-Study. *Journal of Rural Development* **7** (6): 663–673.

Shackelton, C.M., Shackelton, S.E., Buiten, E. and Bird, N. (2007). *The importance of woodlands and forests in rural livelihoods and poverty alleviation in South Africa*. Forest Policy and Economics 9(5): 558–557.

Sharawi, H.A. (2006). *Optimal land-use allocation in central Sudan.* Forest Policy and Economics, *8*(1), 10-21. (http://dx.doi.org/10.1016/j.forpol.2004.04.006)

Sileshi, G.W. (2008). *Farmers' perceptions of tree mortality, pests and pest management practices in agroforestry in Malawi, Mozambique and Zambia.* Agroforestry systems, 72 (2), 87–101.

Sileshi, G.W. (2011). *Integration of legume trees in maize-based cropping systems improves rain use efficiency and yield stability under rain-fed agriculture.* Agricultural water management, 98 (9), 1364–1372.

Simons, AJ., Jaenicke, H., Tchoundjeu, Z., Dawson, I., Kindt, R., Oginosako, Z., Lengkeek, A., and DeGrande, A. (2000). The future of trees is on farms: Tree domestication in Africa. *Forests and Society: The role of research.* XXI IUFRO World Congress, Kuala Lumpur, Malaysia: 752-760.

Simmons, C.S., Walker, R.T. and Wood, C.H. (2002). *Tree planting by small producers in the tropics: a study of Brazil and Panama*. Agroforestry Systems 56(2): 89–105.

Slingo, J.M., Challinor, A.J., Hoskins, B.J. and Wheeler, T.R. (2005). Introduction: food crops in a changing climate. *Philosophical transactions of the royal society B-biological sciences*, 360 (1463), 1983–1989.

Snelder, D.J. and Lasco, R.D. (2008). Smallholder Tree Growing in South and Southeast Asia. *Smallholder Tree Growing for Rural Development and Environmental Services. Lessons from Asia.* Springer 2008.

Stockholm Environmental Institute (SEI). (2009). Economics of climate Change in Kenya, Final Report submitted in advance of COP 15 meeting.

Stoler, A. (1998). *Garden use and household consumption pattern in Javanese village.* [Unpublished Ph.D Thesis, Department of Anthropology, Columbia University, New York. 145pp.]

Stubenitsky, K. and Mela, D.J. (2000). *Consumer perceptions of starchy foods.* British Journal of Nutrition 83:277-285.

Suleiman, R. A. and Rosentrater, K. A., (2015). *Current Maize Production, Postharvest Losses and the Risk of Mycotoxins Contamination in Tanzania.* Conference Proceedings and Presentations. New Orleans, Louisiana. July 26 – 29, 2015.

Summers, P.M., Browder, J.O. and Pedlowski, A.M. (2004). *Tropical forest management and silvicultural practices by small farmers in Brazilian Amazon: recent farm-level evidence from Rodonia.* Forest Ecology and Management 192(2–3): 161–177.

Taking root. (2013). *About our boundary planting method*. https://takingroot.org/2013/01/about-our-boundary-planting-method

Teagasc Agriculture and Food Development Authority (TAFDA). (2007). "A road map for the Farm Forestry Sector to 2015," Tech. Rep., Dublin, Ireland.

Tengnas, B. (1994). Agroforestry extension manual for Kenya. International Centre For Research In Agroforestry

Tefera, A., Rao, M.R. Mathuva, M.N., Atta-Krah K. (1999). *Farmer-participatory Evaluation of grevillea robusta in Boundary planting in semi-arid Kenya*. Forest, Trees and Livelihood 11: 13-27

Terra, G.T.A. (1994). Mixed – garden Horticulture in Java. *Malaysian Journal of Tropical Geography 4. 33 – 43.*

Thangata, P. (1996). *Resource Poor Farmers' Perception of Agroforestry Practices—A Case Study of Malawi. [Unpublished MSc dissertation*. University of Edinburgh, Scotland, UK].

Thacher, T., Lee, D.R., & Schelhas, J.W. (1997). *Farmer participation in reforestation incentive programs in Costa Rica.* Working paper 97-11. Department of Agricultural, Resource and Managerial Economics; Cornell University, Ithaca, New York.

The Ministry of Devolution and Planning's report (2014), *Socio-Economic Atlas of Kenya' – which is based on the 2009 Kenya Population and Housing Census data*. https://www.nation.co.ke/counties/Kakamega-Poverty-Devolution-Ministry-Report

Thoai, T. Q. and Rañola, R. F. Jr. (2010). Decision making by upland farmers on forest management in the northwest mountainous region of Vietnam. J.ISSAAS Vol. 16, No. 1:68-82

Topfarmer. (2018). How to grow grevillea trees and make money. http://topfarmer.co.ke/how-to-grow-grevillea-trees-and-make-money/

UNFCCC (2008) *Challenges and opportunities for mitigation in the agricultural sector*. Technical Paper, United Nations Framework Convention on Climate Change.

United Nations. (2019). *World Population Prospects*: The 2015 Revision. New York: UN DESA Population Division.

UNEP, FAO and UNFF (2009). *Vital forest graphics*. Nairobi, Kenya: UNEP.

Van Noordwijk, M., Roshetko, J.M., Angeles, M.D., Fay, C. and Tomich, T.P. (2008). *Farmer Tree Planting Barriers to sustainable Forest Management.* Smallholder Tree Growing for Rural Development and Environmental Services. Lessons from Asia. Springer 2008.

Vedeld, P. Angelsen, A. and Bojo, J. (2007). *Forest environmental incomes and the rural poor.* Forest Policy and Economics 9:869-879.

Verchot, L. (2007). *Climate change: linking adaptation and mitigation through agroforestry.* Mitigation and adaptation strategies for global change, 12 (5), 901–918.

W. T. Bunderson, Z. D. Jere, I. M. Hayes and H. S. K. Phombeya (2002). *Land Care Practices in Malawi.* Malawi Agro forestry Extension Project, Publication No. 42, Lilongwe.

Watkins, C., Williams, D., Lloyd, T. (1995). Turning farmers into foresters via market liberalization. *Journal of Agricultural Economics* 46, 361-73.

Weyerhaeuser, H., Kahrl, F. (2006). Planting trees on farms in southwest China—enhancing rural economies and the environment. Mt Res Dev 26:205–208.

Widney, S., Burnell C., Vogt, J. (2016). *Tree Mortality Undercuts Ability of Tree-Planting Programs to Provide Benefits: Results of a Three-City Study*. Indiana University, Bloomington, IN 47405, USA.

Wiersum, K.F. (1982). *Tree gardening and taungya on Java: Examples of agroforestry techniques in the humid tropics.* Agroforestry Systems 1: 53–70.

Wilson, B. (2002). Influence of scattered paddock trees on surface soil properties: a study of the Northern Tablelands of NSW. Ecological Management and Restoration 3**:**211–219.

World Agro-forestry Centre. (2009). *"Creating an Evergreen Agriculture in Africa for food security and environmental resilience,"* Tech. Rep., World Agro-forestry Centre, Nairobi, Kenya.

World Bank. (1995). Costs benefits and farmer adoption of Agroforestry, Riau, and South Kalimantan, forests, trees and livelihoods, environment paper number 14.

World Bank. (2001). World development report 2000/2001: *Attacking poverty*. Oxford, UK: Oxford University Press.

World Bank. (2004). *Sustaining Forests: a development strategy*. Washington D.C.

World Bank. (2010). World Bank Indicators – Land use. Kenya.

Zomer RJ, Trabucco A, Coe R, Place F, van Noordwijk M, Xu JC. 2014. *Trees on farms: an update and reanalysis of agroforestry's global extent and socio-ecological characteristics.* Working Paper 179. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. DOI: 10.5716/ WP14064.PDF

Zubair, M. (2002). *An application of theory of planned behavior and logistic regression models to understand farm level tree planting and its determinants in the district of Dera Ismail Khan of Pakistan's North West Frontier Province.* [Unpublished PhD thesis. University of Reading, United Kingdom].

APPENDICES

Appendix I: Household Questionnaire

INTRODUCTION

Good morning/ afternoon. I am conducting a survey on Social determinants of adoption of on-farm tree planting and its contribution to household income in Shinyalu, Kakamega County. The information will be used for academic purposes and also help the government in its development planning. Please allow me to ask you a few questions. The information you provide will be treated with utmost confidentiality. For further clarification please contact:-

Thalma Khalwale
0720985258

GENERAL INFORMATION

Questionnaire number:…….Enumerator:…….

Location:……Sub-Location…….

Village:……. Date:…….

EXTENT OF ON-FARM TREE PLANTING ADOPTION

1. What type of on-farm tree planting patterns and configurations do you practice on your farm?
   (Rank the multiple answers)

Rank	Tree planting technologies	Reason for preference
[ ]	Trees on boundaries	
[ ]	Woodlots	
[ ]	Scattered trees	
[ ]	Alley cropping	
[ ]	Fruit trees	
[ ]	Fodder banks	
[ ]	Contour ploughing	
[ ]	Improved fallows	
[ ]	Medicinal trees	
[ ]	Other specify……	

2. Name the species of trees currently grown on-farm and reasons for planting? Please fill the table below

Scientific name/Local name	No. of trees	Natural/ Planted	No planted within 1 year	Reason for planting

3. What motivates you to plant trees on your farm? (Rank the multiple answers)
   [ ] Income generation [ ] Aesthetic value (beauty) [ ] Adequate land
   [ ] Soil Conservation [ ] Fodder [ ] Firewood [ ] Fruits [ ] Timber [ ] Poles
   [ ] Fence [ ] Climate amelioration [ ] Medicinal values [ ] Cultural values
   [ ] other (specify) …….....……

4. Have you ever been trained on tree planting? [ ] Yes [ ] No. If Yes, by which organization? [ ] GOK [ ] NGO [ ] CBOs/FBO [ ] other (specify)……..

5. If No, how did you acquire knowledge on the importance of planting trees?
   ……
   ……
   …….

6. What is the survival rate of tree seedlings planted on farms? [ ] 0 - 10% [ ] 11% - 20% [ ] 21% - 30% [ ] 31% - 40 % [ ] 41% - 50% [ ] Above 50%

7. What do you think needs to be done to ensure continued adoption of on-farm tree planting technologies?
   i. ……..
   ii. ……..
   iii. ……..
   iv. ……..

SOCIAL FACTORS INFLUECING ADOPTION OF ON-FARM TREE PLANTING

8. What are the main social factors that influence adoption of on-farm tree planting (Rank your responses)?

	FACTOR	RANK
1.	Age	
2.	Land size/ Labour	
3.	Family size	
4.	Farm and off-farm income	
5.	Education level	
6.	Availability of market	
7.	Access to existing forest services/ Distance to the forest	
8.	Gender	
9.	Access to credit	
10.	Other (Specify)	

Ranking: 1= Important, 2= Not important

9. Do the above social factors (15. Above) affect your attitude towards on-farm tree planting?
   [ ] Sometime [ ] Once in a while [ ] Not at all

10. Does the age of the household head affect adoption of on-farm tree planting?
    [ ] Yes [ ] No. If yes, how?
    ……
    ……..

11. Does your family size affect your on-farm tree planting options? [ ] Yes [ ] No. If yes, Explain
    ……
    ……
    ……

12. Does the household head main economic activity/occupation affect on-farm tree planting activities? [ ] Yes [ ] No. If Yes, how?
    ……
    ……
    ……

13. Estimate your average annual income from the following activities: -

Activity	Income (Kshs)
Crop sales (Annual crops)	
Livestock sales	
Livestock products(Milk, skin, hide, wool)	
Sale of tree and tree products	
Renting out land	
Payment for residential/commercial buildings	
Business	
Employment	
Other (Specify)…….	

14. Has your education level been useful in your tree planting activities? [ ] Yes [ ] No. If Yes Explain,

……

……

……

15. What is your land size (in acres)? …….

16. Do you own this land? [ ] Yes [ ] No

17. Type of ownership: [ ] Individual [ ] Family [ ] Rental [ ] Leasehold [ ] other, specify …….....

18. Land use systems (apportion the size of land in acreage):

Land use	**Acreage**	**Land use**	**Acreage**
1. Agricultural crops cultivation		5. Fruit orchard	
2. Livestock rearing paddock		6. Woodlot/ forest	
3. Fodder crops cultivation		7.others	
4. Homestead			

19. Does the size of your land influence your on-farm tree planting activities? [ ] Yes [ ] No .If Yes, how……..

……

……

20. What is the approximate distance of the nearest edge of Kakamega forest from your home? ……(km). Does this distance affect your tree planting activities? [ ] Yes [ ] No. If yes, how?

……

……

……Do any of your household members directly source for products from the forest? [ ] Yes [ ] No. If yes, which key products did your household obtain from the forest in the past one year and at what frequencies (fill the table below)?

Forest product	**Household member**	**Unit**	**Quantity obtained**	**How many times per month**

	mostly involved			
Firewood				
Grass for fodder				
Grazing				
Pole wood				
Thatching materials				
Medicinal extracts				
Others (Specify…)				

Household member codes: 1= HH head; 2= Spouse; 3= Children; 5= other (specify).....

Unit codes: 1= Kilogram; 2= Number; 3= Head load; 4= Bundle; 5= Sack; 6= other (specify).....

21. Is there ready market for tree products in this area? [ ] Yes [ ] No. If No, Why? …… ……

22. Who plants trees on the farm? [ ] Wife [ ] Husband [ ] Both wife and husband [ ] Children [ ] Whole family [ ] Others specify…….

23. Who tends to the trees? [ ] Wife [ ] Husband [ ] Both wife and husband [ ] Children [ ] Whole family [ ] others specify…….

24. Who owns the trees? [ ] Wife [ ] Husband [ ] Both wife and husband [ ] Children [ ] Whole family [ ] others specify…….

25. Who decides when and how to harvest them? [ ] Wife [ ] Husband [ ] Both wife and husband [ ] Children [ ] Whole family [ ] Others specify…….

26. Have you had an account with any financial or credit institutions in the last 5 years? [ ] Yes [ ] No

27. Have you received any formal credit in the last 5 years? [ ] Yes [ ] No. If Yes, how has it influenced your tree planting activities? …… …… ……..

CONTRIBUTION OF ON-FARM TREE PLANTING TO HOUSEHOLD INCOME

28. What other farming practices do you have on your farm apart from tree planting in order of preference?

Farming practices	Rank	Reason for preference
Crop production		
Livestock keeping/ dairy farming		
Bee keeping		
Others (specify)……		

29. What are the values of inputs used in crop production and tree planting in the past 12 months (cash expenditures)?

Inputs	Crop production	Tree planting
Fertilizer		
Labour		
Seeds /seedling		
farm machineries		
leasehold expenses		
Other specify……..		

30. Does crop production from your farm meet your household food requirements? [ ] Yes [ ] No. If No, where do you get alternative sources of food?
[ ] Markets [ ] Sell of milk [ ] sell of fruits [ ] sell of tree products [ ] Business [ ] Support from Relatives [ ] support from GOK [ ] Churches/NGOs
[ ] Other (specify)……

31. In the past 3 months, approximate how much you have made from the sale of the following produce?

farming practices	Selling 1=yes 2=no	Income in past 3 month
Crop produce?		
Sale of milk		
Tree products		
Sell of fruits		
Other specify……		

32. Do the trees on your farm act as fodder for the animals? [ ] Yes [ ] No. If Yes, which species? [ ] Eucalyptus [ ] Grevelia [ ] Calliandra [ ] Lucina [ ] other (specify)…….

33. In your opinion, has engagement in tree planting on your farm improved your livelihood?
[ ] Yes [ ] No. If yes, how has it improved your livelihood?

……..……

……

……

34. How would you rate the farming practices on your land? 1= Very important;
2= Important 3= Not important at all

Farming practice		**Rate**
1.	Tree planting	
2.	Crop production	
3.	Livestock keeping/ Dairy farming	
4	Bee keeping	
5.	Others (Specify)……	

35. What challenges do you face in on-farm tree planting?

i. ……
ii. ……
iii. ……
iv. ……
v. ……
vi. ……

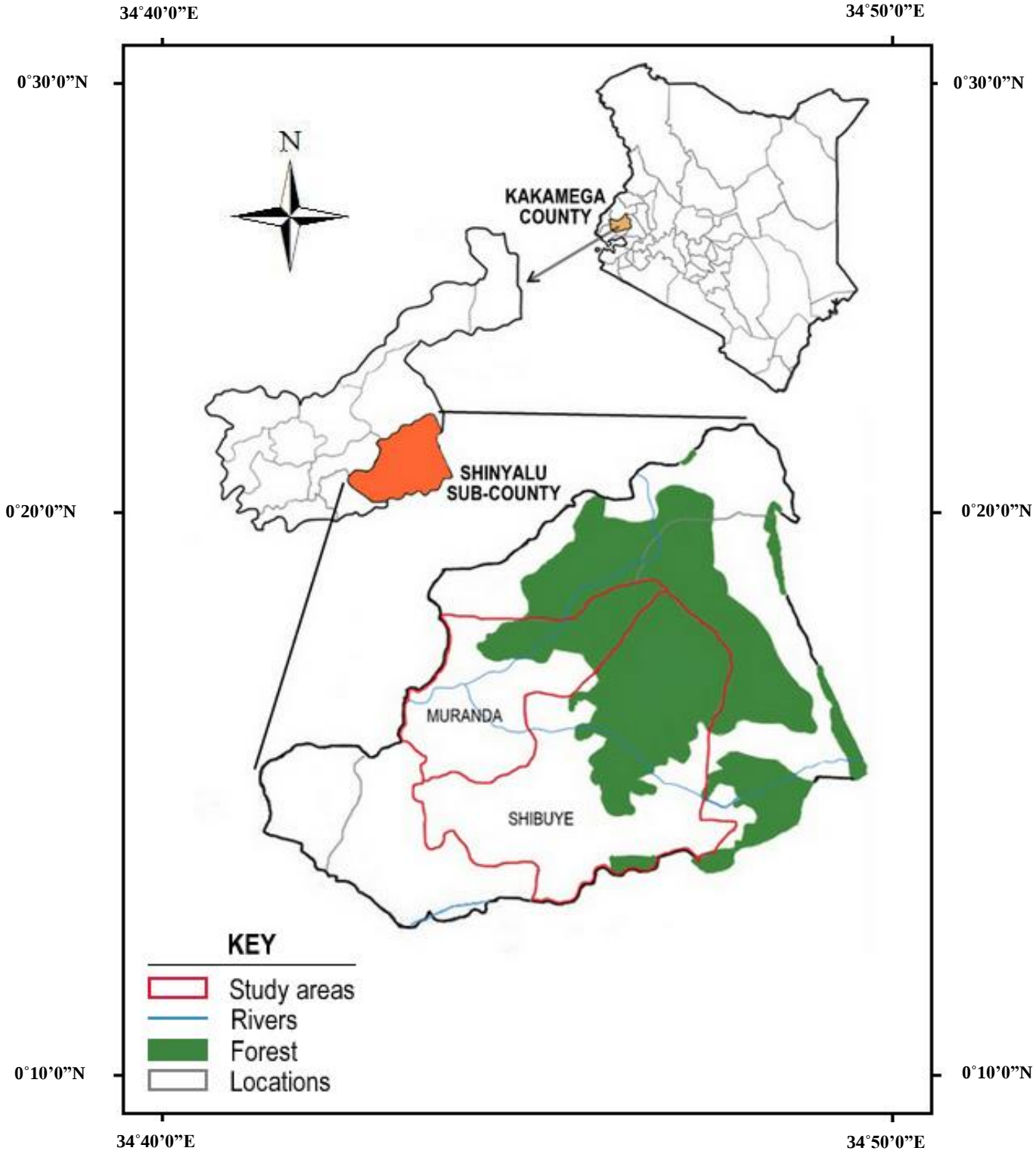
Appendix II: Guide for Focus Group Discussion

1. What are various farming practices used by most farmers?
2. What do the people know about tree planting?
3. Is tree planting of great interest to people?
4. What is the most common type of tree species planted on-farms?
5. What are the major on-farm tree planting patterns and configurations used?
6. Why do you prefer the above patterns and configurations?
7. What challenges do you face in adopting these patterns and configurations?
8. What is the survival count of seedlings planted on farms?
9. What are the main income generating activities in the area?
10. What are the main social factors influencing adoption of on-farm tree planting in the area?
11. What are the main challenges facing farmers in on-farm tree planting?
12. What are the major threats facing conservation of the forest?

Appendix III: Guide for Key Informant Interviews

1. What is the general history of this area?
2. How many villages are there in this location?
3. What is the ethnic composition of this area?
4. What are the major farming practices this area?
5. What are the types of land ownership in this area?
6. Are people allowed access to the forest?
7. What are the main products obtained from the forest?
8. Which products have the highest source of income?
9. What are the attitudes of farmers towards on-farm tree planting in this area?
10. Have farmers embraced on-farm tree planting as part of their farming practices?
11. What are the major hindrances to adoption of on-farm tree planting?

Appendix IV: Map of Shibuye and Muranda study locations



Source: Own GIS Production