SOCIO-ECONOMIC AND PSYCHOLOGICAL FACTORS INFLUENCING SMALL-SCALE FARMERS' ADOPTION OF FARM-FORESTRY POLICY IN NAROK NORTH SUB-COUNTY, KENYA

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A Thesis Submitted to the Board of Post Graduate Studies in Partial Fulfilment for the Requirements for the Award of Master of Research and Public Policy Degree of Egerton University

EGERTON UNIVERSITY

NOVEMBER, 2019

DECLARATION AND RECOMMMENDATION

Declaration

I declare that this thesis is my original work and has not been presented for a degree in this or any other university.

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Recommendations

This research thesis has been prepared and submitted for examination with our approval as the Egerton University supervisors.

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DEDICATION

With love and sincere gratitude I dedicate this research work to my dad David ole Naeku, my mum Juliana Masago, my son Kishoyian, my brother Kalool and my sisters Nairesiae and Pasiyo.

ACKNOWLEDGEMENT

Firstly, I am grateful to the Almighty God for His immense love, grace, mercy, strength and guidance in my life and during this study period. Secondly my gratitude goes to Egerton University for according me the opportunity to undertake this master's programme. My profound gratitude also goes to my research supervisors Prof. Margaret Ngigi and Prof. Mark Okere for their tireless guidance, advice, insightful criticisms and supervision throughout the entire research and thesis writing process. I am also very grateful to Deutscher Akademischer Austauchdienst Dienst (DAAD) and Partnership for African Social & Governance Research (PASGR) for the partial scholarship they awarded me that gave me the financial support and impetus during my studies. Much gratitude also goes to all my classmates especially Zeinab Mzungu and my friends Dennis Kyalo and Gladys Mutua for their brilliant scholarly advice and encouragement throughout my studies. Special thanks also go to the research enumerators especially Edward Sururu and Ruth Memusi as well as the farmers that took part in this study for their willingness to participate and honesty which contributed immensely to the quality of data and research findings. Lastly I am grateful to all my friends and family members who contributed in one way or another to my success during this study period.

ABSTRACT

The government of Kenya has over the years promoted the adoption of farm-forestry through various programmes and initiatives with the aims of reversing land degradation and increasing forest cover. One of the most recent efforts was through the establishment of the farm-forestry rules of 2009 which stipulated that 10% of agricultural land should be under trees. However, farm-forestry adoption in the country has remained sub-optimal causing concerns to policy makers. This study, therefore, encompassed both socio-economic and psychological factors to gain a holistic understanding of the adoption of farm-forestry in Narok North Sub-County. An explanatory sequential mixed method research design was used in which quantitative data was first collected followed by the collection of qualitative data. The Nassiuma's equation was used to calculate the sample size for the quantitative research and a sample size of 110 small-scale farm households was obtained. The quantitative study used a two-stage sampling procedure whereby in the first stage proportionate sampling was used and the second stage involved simple random sampling. Purposive sampling was used for the qualitative data in which 10 farm-forestry adopters and 10 non-adopters were selected based on their tree density levels. Quantitative data was obtained using a structured questionnaire while qualitative data was collected using interview guides. The instruments were validated prior to the collection of data. A pilot test was carried out with 10 farming households in Narok East Sub-County and the reliability of the instrument was determined using cronbach's alpha coefficient. The reliability test yielded a coefficient of 0.79 which was deemed sufficient. The results of this study showed that there was a statistically significant relationship between age-group, gender, level of education, extension contact and farmer-group membership and adoption of farm-forestry. Land tenure status and agricultural enterprise were also found to significantly influence the adoption of farm-forestry. While the land sizes of farm-forestry adopters and non-adopters were found to be significantly different. There were also statistically significant differences between the attitude, subjective norm and perceived behavioural control of farm-forestry adopters and non-adopters. The results of the Tobit model showed that gender and land tenure status significantly predicted adoption of farm-forestry. The results of the qualitative data analysis revealed that both farm-forestry adopters and non-adopters understood the importance of practising farm-forestry. However, the farm-forestry non-adopters felt that farm-forestry was a long-term and risky venture that was both knowledge and resource intensive. Therefore trainings to equip farmers with knowledge and skills on farm-forestry practice and other forms of support prove imperative if the government intends to increase the adoption of farm-forestry.

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ABBREVIATIONS AND ACRONYMS

ASAL	Arid and Semi-arid lands
ASDP	Agricultural Sector Development Support Programme
CEEPA	Centre for Environmental Economics and Policy in Africa
CBD	Convention on Biodiversity
COP	Conference of the Parties
DRSRS	Department of Resource Surveys and Remote Sensing
FAO	Food and Agriculture Organization
GoK	Government of Kenya
ICRAF	International Centre for Research in Agro-forestry
IPCC	International Panel on Climate Change
KEFRI	Kenya Forest Research Institute
KFS	Kenya Forest Service
KFWG	Kenya Forests Working Group
NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Plans of Action
NGOs	Non-governmental Organizations
OECD	Organization for Economic Co-operation and Development
PBC	Perceived Behavioural Control
TPB	Theory of Planned Behaviour
UN	United Nations

CHAPTER ONE
INTRODUCTION

1.1 Background to the study

Deforestation is a major problem worldwide; the International Union for the Conservation of Nature has noted that over half of the world's forests have been destroyed since the 1960s. Moreover, they indicated that a hectare of tropical forest is destroyed every second (IUCN, 2019). Furthermore, studies indicate that Africa has the world's fastest rates of deforestation; this is said to be a result of the continent's overdependence on primary resources (Ademiluyi, Okude, & Akani, 2008). Narrowing this down, statistics show that within a span of about 43 years, from 1963 to 2006, Kenya's closed canopy forest cover was reduced from 10% to a mere 1.17% (KFWG/DRSRS, 2006), falling way below the world's closed forest canopy of 24.1% and the African average of 9.3%. Moreover, Kenya's forest cover currently stands at 7.4%, lower than the globally and constitutionally recommended forest cover of 10%. This worrying trend is particularly evident in Narok County which is home to the Maasai Mau, Olposimoru and the Enosupukia forests. The County is said to have lost a considerable forest cover on both the farmlands and the gazetted forests. Studies have shown that between 1996 and 2003 30% of the Maasai Mau forest had been deforested (Sena, 2006).

Agricultural expansion is reportedly the main driver of these high rates of deforestation as forested areas are continuously cleared to pave way for cropping activities. High potential areas have especially experienced agricultural intensification to the detriment of the environment and trees. Meanwhile, Arid and semi-arid lands such as areas in Narok County have undergone land use changes from pastoralism to agro-pastoralism as they are increasingly being cultivated; a situation reportedly caused by population increase (Ojwang', Agatsiva, & Situma, 2010; FAO, 2010; Achalu & Negash, 2006; Bishaw & Abdelkadir, 2003). The other driver of deforestation is the demand for wood products, which in Kenya is noted to be high, especially the demand for charcoal; which is said to provide 82% and 34% of urban and rural household energy respectively (Kenya Forest Service, 2014). The increasing demand for forest products and land caused by both high population growth and escalating rural poverty has led to the loss of trees on farmlands, overharvesting in plantations and degradation of the few public forest to the point where they can no longer sufficiently provide water, wood product and other ecosystem services (Kenya Forestry Research Institute, 2008; Ojwang', Agatsiva, & Situma, 2010).

The major consequences of this massive deforestation on farmlands and public forests are increased vulnerability to climate change and variability, increased wood deficits and land degradation. The horn of Africa region, in particular is has been reported to have high rates of deforestation is said to be experiencing severe land degradation. Consequently, this has resulted to the agricultural sector in the region being highly vulnerable thereby increasing food insecurity, water scarcity and poverty (Bishaw, Mowo, Kassa & Muriuki, 2013; Oxfam, 2010; CEEPA, 2006; Regassa, Givey & Gina, 2010).

Due to high levels of rural poverty and high dependence on rain-fed agriculture, trees have for years acted as a buffer against increased climatic variability, providing farmers with income through sales of charcoal, firewood and other tree products in cases of crop failure (Hilbur, 2014: Bishaw *et al.,* 2013). Therefore, absence of trees due to high rates of deforestation increases vulnerability to climate change and variability. Moreover deforested landscapes are more likely to experience low agricultural productivity than forested under the current challenges of climate change. This is because trees promote agricultural productivity; through their ability to temper severe weather such as floods and high temperatures (Ojwang', Agatsiva, & Situma, 2010).

Deforestation also contributes to land degradation and declining soil fertility as landscapes devoid of trees are more prone to high rates of soil erosion and soil degradation. In its Land degradation assessment 2014 report, the Ministry of Environment, Water and Natural Resources noted that land degradation in Kenya is widespread and worsening, deforestation and charcoals burning were identified as the major causes of it. Wood fuel accounts to 70% of national energy use yet forests cover only 6.99% of total land in Kenya (Government of Kenya, 2012). In contrast, the high deforestation rates in Kenya are continuously decreasing the supply of wood products, while on the other hand the demand for wood products is on the increase, creating a deficit (Government of Kenya, 2012).

One major way of countering the high rates of deforestation and addressing land degradation and wood deficits is through promotion of farm-forestry. Farm-forestry which is defined as the integration and management of trees on farmland is a sustainable land use practice that is climate smart and has been proven to prevent and reverse land degradation. In light of the problems caused by deforestation, farm-forestry is a viable land use practice that meets the demand for wood products while sustaining and even increasing agricultural productivity.

Additionally farm-forestry holds the potential of increasing forest cover in Kenya towards the constitutionally prescribed forest cover of 10% from the current level of 2% (Forest Act, 2006). This increase can be achieved directly through widespread adoption and increase in the number on trees on farmlands or indirectly through reducing the exploitation of existing forests by supplying wood products (that would have otherwise from the forests) to meet the increasing demand for the products.

Farm-forestry offers a wide range of benefits to the farmer, the farm and the environment. These benefits range from providing economic products in terms of timber and wood fuel, to providing ecosystem services, enhancing climate change combating mechanism and even increasing household nutrition levels (Garrity et al. 2010). Furthermore, farm-forestry enables sustainable production of wood fuel; timber and fruit trees and farmers can directly benefit through reduction in household fuel costs and nutrition costs. Moreover, farm-forestry can contribute significantly to local economies when farmers earn extra income from sales of tree products.

Farm-forestry can also indirectly benefit the farmers in many ways including prevention of soil erosion and land degradation. This occurs through trees 'extensive root systems that holds the soil together and through wind breaking which prevents wind erosion; indeed landscapes with trees are more likely to last and are more productive (Mercer, 2004). In addition leguminous trees when incorporated in farms will increase soil fertility through nitrogen fixation mechanism and also provide nutrition for livestock thus promoting agricultural productivity (Bishaw *et al.,* 2013 Ajayi, 2007).

Trees also provide positive externalities through the integral role they play in combating climate change; through the process of photosynthesis they naturally absorb carbon dioxide, a major greenhouse gas thus acting as a significant carbon sink (Garrity et al. 2010). Farm lands are said to be potential carbon sinks that could absorb a lot of carbon if trees are planted or maintained and intentionally managed on them (Albrecht & Kandji, 2003; Bishaw *et al.,* 2013).

There have several international efforts over the years to advocate for farm-forestry as a viable land use practice. One main one is the Kyoto protocol of 1992, in which signatories of the protocol including Kenya; made commitments to reduce carbon emissions and to increase rates of carbon removal and storage from the atmosphere. The protocol sought to achieve this

through various mechanisms one of which included the clean development mechanism; which was to be applied in afforestation and reforestation projects (IPCC, 2000). In addition, International Panel on Climate Change third Assessment Report on Climate Change recognized the potential of farm-forestry in tackling numerous problems and delivering economic, environmental and social benefits (McCarthy, Canziani, Leary, Dokken, & White, 2001). The Food and Agriculture Organization of the United Nations also recognized the importance of trees outside forests during the Kotka meeting of 1993 and has since then worked to create awareness of importance of farm-forestry at the national policy levels of developing countries (Syaka & Castillo, 2003). Additionaly, the United Nations Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change (IPCC) recognized farm-forestry as a crucial element of climate-smart agriculture (IPCC, 2000). Furthermore, in the Conference of the Parties (COP) meeting in Durban, 2011, farm-forestry was identified as having a great potential for climate change adaptation and mitigation (UN, 2011). Moreover, National Adaptation Plans of Action (NAPAs) and Nationally Appropriate Mitigation Actions (NAMAs) speak of farm-forestry as an essential constituent in the agricultural sector actions. Additionally, the United Nations Convention to Combat Desertification recognizes the potential that farm-forestry has to control desertification and enable rehabilitation of deserts (FAO, 2015). Farm-forestry has been appreciated as a key practice in the ecosystem approach recommended by the Convention on Biodiversity (FAO, 2010).

Following the 2014 World Agroforestry Congress held in New Delhi; India became the first country in the world to draft, adopt and implement a national policy on Agroforestry/farm-forestry. Granted India like other countries had agroforestry related guidelines, the country went ahead to design and implement a comprehensive agroforestry policy. The country also hopes that through agroforestry, they can attain the target forest cover of 33% (Government of India Department of Agriculture & Cooperation Ministry of Agriculture, 2014).

In Kenya, the earliest efforts by the government to encourage adoption of farm-forestry were through the Kenya Wood fuel and Agroforestry Programme in the 1980s (Tengnas, 1994). The aim of the programme was to increase wood fuel production after a study showed that there was a large and increasing gap between demand and supply of wood fuel, and the standing stock, of wood was estimated to decline by about 30% in the period 1980-2000 (Tengnas, 1994). Furthermore The National Soil and Conservation Programme of 1992

incorporated promotion of agroforestry as one of the ways to conserve soil and water (Tiffen, Purcell, Gichuki, Gachene, & Gatheru, 1996).

The Kenyan Government has over the recent years has been given special attention to farm-forestry in the forest act of 2005 and the Forest Policy of 2007, which stressed that the development of farm-forestry was an approach to increase forest cover, diversify subsistence products and income, while contributing to soil and water conservation (GoK, 2012). Furthermore, the Climate Change Action Plan 2013-2017, acknowledged forestry as having the largest potential for climate change mitigation, it also cited climate smart agriculture and agro-forestry as priority actions in the climate change mitigation and adaptation (Government of Kenya, 2012). However the most decisive effort by the Government to promote farm-forestry was the establishment of Farm-forestry rules in 2009. This was done in cognizance of the problems caused by land degradation and farm-forestry's ability to make agricultural production more resilient to climate change. These rules stipulated that farm-forestry should be established on at least 10% of all agricultural land holdings (FAO, 2009).

Despite these international and local initiatives farm-forestry adoption in the Kenya has remained sub-optimal causing concerns to the government and policy makers. Moreover little is known about the factors that cause some farmers to more easily adopt the practice than others. This research, therefore, encompassed both socio-economic and psychological factors to gain a holistic understanding of the adoption of farm-forestry in Narok North Sub-County and make recommendations that would improve the implementation of the policy.

1.2 Statement of the problem

Narok-North Sub-County has undergone tremendous land use changes over the years; from pastoralism to agro-pastoralism and felling of trees on farmlands and deforestation is widespread. As a result the county is said to be one of the most highly deforested and degraded regions of Kenya. This is despite the fact that the economy of the county is highly dependent on natural resources through the agricultural and tourism industries. The government of Kenya, however, has over the years made efforts to tackle these widespread problems through promoting farm-forestry also called agroforestry. More recent initiatives were through the establishment of farm-forestry related policies, this includes the forest policy of 2007 and the farm-forestry rules of 2009. However little is known about the adoption of the farm-forestry in Narok North Sub-County and the factors that would influence adoption of the practice. This study encompassed both socio-economic and

psychological factors to gain a holistic understanding of the adoption of farm-forestry policies.

1.3 Purpose of the Study

The purpose of the study was to examine the influence of socio-economic and psychological factors on the adoption of the farm-forestry among small-scale farmers in Narok North Sub-County. The socio-economic factors for this study were farmer-specific characteristics and farm-specific characteristics while psychological factors were attitude, subjective norms and perceived behavioural control.

1.4 Objectives of the Study

1. To determine the influence of farmer-specific socio-economic characteristics on the adoption of farm-forestry policy in Narok North Sub-County, Kenya.
2. To determine the influence of farm-specific socio-economic characteristics on the adoption of farm-forestry policy in Narok North Sub-County, Kenya
3. To compare the differences in psychological factors of adopters and non-adopters of farm-forestry policy in Narok North Sub-County, Kenya.
4. To determine which socio-economic and psychological factors predict adoption of farm-forestry policy by small-scale farmers in Narok North Sub-County, Kenya.

1.5 Hypotheses of the Study

1. Farmer-specific socio-economic characteristics do not significantly influence the adoption of farm-forestry policy in Narok North Sub-County, Kenya.
2. Farm-specific socio-economic characteristics do not significantly influence the adoption of farm-forestry policy in Narok North Sub-County, Kenya.
3. There is no statistically significant difference in the psychological factors of adopters and non-adopters of farm-forestry policy in Narok North Sub-County, Kenya.
4. Socio-economic and psychological factors do not statistically significantly predict small-scale farmers' adoption of farm-forestry policy in Narok North Sub-County, Kenya.

1.6 Significance of the Study

This study aimed to generate information that might inform future formulation and implementation of agro-environmental policies in Kenya. This study might perhaps provide information to NGO's interested in promoting farm-forestry in the study area. It might

possibly be of help to the farmers in that the hindrances and challenges they face while trying to adopt farm-forestry will be highlighted so that action by authorities may be taken to enable smooth adoption of farm-forestry. This study also contributes to the literature on understanding behaviour of farmers with regards to adoption of farm-forestry.

1.7 Scope of the Study

The study was conducted in Narok North Sub-County, Narok County. It featured small-scale farmers who practice crop farming, pastoralism and agro-pastoralism in both the highland humid zone and the lowland sub humid dry-land zone of the Sub-County. Specifically the study focused on the practice of farm-forestry by critically assessing the influence of socio-economic and psychological factors on the adoption of farm-forestry among small scale farmers in Narok North Sub-County. These socio-economic factors were farmer-specific characteristics (age, gender, level of education, off-farm income, farmer-group membership, social capital and extension contact) and farm-specific characteristics (land tenure, agricultural enterprise and land size). The psychological factors were the intention to practice farm-forestry measured using the theory of planned behaviour's three constructs namely attitudes, subjective norms and perceived behavioural control.

1.8 Limitation of the Study

The study was conducted in Narok North Sub-County and therefore the findings may not be generalizable to the other regions of Kenya.

1.9 Assumption of the Study

The study was guided by the assumption that respondents were ready and willing to participate in the study by providing honest and accurate information on the issues raised.

1.10 Operationalization of Terms

Adoption: The online Cambridge dictionary defined as adoption as accepting and starting to use something new. In this study it will imply the uptake and integration of farm-forestry by a farmer. Farm-forestry adopters will be small-scale farmers who have planted 40 trees and more per hectare (16 and above trees per acre) on their farms.

Attitude: The conventional definition of attitude according to the online Cambridge dictionary is "a feeling or opinion about something or someone, or a way of behaving that is caused by this". The definition adopted by this study is the one from the Theory of Planned Behaviour which is "person's general feeling of favourableness or unfavourableness towards an object".

Cut-off: This has been defined by the online Cambridge dictionary as "a fixed point or level at which you stop including people or things". In this study it implies the threshold that delineates adopters and non-adopters of farm-forestry technologies. For this study the cut-off point is 40 trees per hectare to correspond with the 10% tree cover as per the farm-forestry rules of 2009.

Farm-forestry: The farm-forestry rules of 2009 defined farm-forestry as "the planting and management of trees on farms whether as scattered in the farm in rows, boundaries or in woodlots or private forests". This study will adopt this definition given by the policy.

Farm-forestry policies: This refers to rules, acts and regulations that are related to farm-forestry in Kenya. In this study it refers to the National forest policy of 2014 section 4.5 on farm-forestry and the farm-forestry rules of 2009.

Farmer-specific socio-economic characteristics: This refers to socio-economic characteristics that describe a farmer such as age, gender, education level and so forth. In this study the farmer specific characteristics were age-group, gender, level of education, off-farm income, social capital and extension contact.

Farm-specific socio-economic characteristics: These refer to socio-economic characteristics that relate to a farm. In this study the farm-specific characteristics of interest were land size, land tenure, agro-ecological zone and proximity to market.

Household: A household has been defined by Kenya National Bureau of Statistics (KNBS) as a group of people who normally live and eat their meals together a person or a group of people living in the same compound answerable to the same head. This study adopted this definition in sampling farming households as opposed to individual farmers.

Household head: The KNBS defined a household head a "someone who household members recognize as the authority and main decision maker and that person must actually live with the rest of the household members". This study adopted this definition as the household heads whether male or females were interviewed.

Influence: The Cambridge online dictionary defines influence as "the capacity to have an effect on the character, development, or behaviour of someone or something, or the effect itself". This study will adopt this definition as influence will be seen as the ability of the various factors to have an effect on the adoption decision.

Social Capital: Social capital is defined by OECD as "networks together with shared norms, values and understandings that facilitate co-operation within or among groups". These networks are networks of friends, family networks, networks of former colleagues, and so on. This study adopted this definition.

Small-scale farmers: Most studies categorize small-scale farmers based on land holding. According to the Agricultural Sector Development Support Programme (ASDP) the average land holding in Narok County is 16.2 hectares. For this study, small-scale farmers comprised of farmers who owned between 20 hectares and 0.4 hectares of land (approximately between 1 acre and 50 acres of land).

Socio-economic factors: Refers to indicators looking at both social and economic conditions relevant to the well- being of an individual**.** In this study it is a combination of both social and economic characteristics of a small-scale farmer.

Subjective Norm: According to the Theory of Planned Behaviour it refers to a function of beliefs that are determined by social networks, that is: the person's beliefs that members of his/her social network would approve them performing the behaviour. This study will adopt this definition.

Perceived Behavioural Control: According to the Theory of Planned Behaviour it refers to "the degree to which an individual feels that the performance of the behaviour is under one's volitional control". This study will adopt this definition.

Psychological: This relates to the scientific study of how people's thoughts, feelings, and behaviours are influenced by the actual, imagined, or implied presence of others. In this study the psychological factors of interest were the theory of planned behaviour constructs which are attitude, subjective norms and perception on behavioural control.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter will highlight literature on factors that influence the adoption of Farm-forestry. Particularly it will provide an overview of farm-forestry policies in Kenya, farmer-specific socio-economic characteristics, farm-specific socio-economic characteristics followed by psychological factors. Finally, the chapter closes with a theoretical and conceptual framework.

2.2 An overview of Farm-forestry programmes and policies in Kenya

In Kenya, the earliest efforts by the government to encourage adoption of farm-forestry were through the Kenya Wood fuel and Agroforestry Programme in the 1980s (Tengnas, 1994). This programme started after a study showed that there was a large and increasing gap between demand and supply of wood fuel, and the standing stock, of wood was estimated to decline by about 30% in the period 1980-2000 (Tengnas, 1994). Thus the first efforts in increasing adoption of farm-forestry had an aim of increasing wood fuel production. The programmes that followed this were driven by the need to enhanced soil conservation and reduce soil erosion. In Particular, the National Soil and Conservation Programme of 1992 incorporated promotion of agroforestry as one of the ways to conserve soil and water (Tiffen, Purcell, Gichuki, Gachene, & Gatheru, 1996).

More recent programmes and policies however looked to farm-forestry as critical area in combating climate change, increasing adaptation to climate variability and increasing forest cover in addition to other benefits. The Climate Change Action Plan 2013-2017, acknowledged forestry as having the largest potential for climate change mitigation, furthermore it cited climate smart agriculture and agro-forestry as priority actions in the climate change mitigation and adaptation (Government of Kenya, 2012). Even though Farm-forestry has been given attention in the forest act of 2005 and the Sessional Paper No. 1 of 2007 on Forest Policy, the most decisive effort by the Government to promote farm forestry was the establishment of Farm-forestry rules of 2009. This was done in cognizance of the problems caused by land degradation and also the potential of farm-forestry to make agricultural production more resilient to climate change.

One key element of this policy was the rules stipulate that farm forestry should be established on at least 10% of all agricultural land holdings. Other aspects are that no agricultural landowner should grow any Eucalyptus tree species in riparian land. The rules also stipulated that land owners should ensure that harvesting of trees is done in such a manner that maintains 10% tree cover at all times, with large scale harvesting requiring a harvesting plan as per the provisions of the Forest Act No. 7 of 2005 (Agriculture (farm forestry) Rules, 2009 (Cap. 318); FAOLEX, 2009). This study will focus on the aspect of the farm-forestry rules of 2009 that requires farmers to have 10% of their land under trees as it seeks to determine what factors enable or hinder farmers from implementing this aspect of the policy. This policy is unique in that it addresses farm-forestry directly and promotes its adoption by both small-scale and large-scale farmers.

2.3 Farmer-specific socio-economic characteristics

Certain socio-economic characteristics of farmers and have been shown to either promote or discourage adoption of farm-forestry practices. The farmer characteristics discussed in this study are age, gender, education level, off-farm income, social capital and extension contact.

Age of the farmer is one of the factors which have been found by many studies to influence adoption of farm-forestry. Roger (1993) points out that younger farmers are more innovative, more of risk takers and have a lengthier planning horizon so they are more likely to undertake long term investments such as farm-forestry than their older counterparts. A study in Western Uganda found out that young household heads were more likely to adopt farm-forestry as compared to older household heads (Thangata and Alavalapati, 2003). Similarly, Adesina *et al.,* (2001), found out that the adoption of farm-forestry decreases as age advances. Moreover age was generally found to be a significant factor in deciding whether to continue or not to continue with the farm-forestry technology (Ajayi *et al.,* 2006), older farmers mostly chose not to continue with the technology as compared to younger farmers. In order for the full benefits of farm-forestry to be realized by the farmer, farm-forestry has to be adopted and maintained for lengthy periods of time (Mercer, 2002).

Gender of the farmer is also another factor that is said to influence adoption of farm-forestry practices. A study by Thangata and Alavalapati, (2003) in Malawi and Sanchez and Jama, (2002) in Kenya indicated that the average female-headed households are less likely to practice farm-forestry as compared to the male-headed household. This phenomenon is usually explained by the notion that in Africa women have limited and inadequate control

over productive resources. Moreover, it has been noted that women have heavier workloads and time poverty due to years spent on reproductive responsibilities and possibly also their higher risk aversion towards technology adoption, like that of farm-forestry (Kiptot & Franzel, 2011). For instance the lower adoption of farm-forestry by women in Western Uganda was due to the lack of secure land and tree tenure by women caused by the existence predominantly patrilineal inheritance systems (Thangata and Alavalapati, 2003). Gender is also posited to influence adoption of agricultural technologies indirectly through the acquisition of information as some studies have established that male-headed household are more likely to easily access information about new technologies than female-headed households (Asfaw and Admassie, 2004).

Findings have also established that the education level of farmers is important in determining technology adoption rates which can lead to increased productivity (Amaza and Tashikalma, 2003). Findings by Thangata and Alavalapati, (2003) also revealed that education was positively associated with probability of adopting farm-forestry practices. The study also noted that better educated farmers were usually more flexible, more motivated and easily adapted themselves to changing conditions. The farmers also benefited more from work experiences, acted with better resourcefulness in problem-solving situations, and in overall, were more industrious than those less educated, even when their education had taught them no specific skills. Moreover, Weir and Knight (2000) in studying the adoption of agricultural innovation in Ethiopia noted that educated farmers were more likely to take the initiative in the adoption of technologies and were more likely to be chosen by agricultural extension agents for trainings. Education also influenced adoption of farm-forestry indirectly by increasing the capability of farmers to utilize their resources efficiently and improved farmer's capacity to obtain, analyse and interpret information (Amaza and Tashikalma, 2003). Moreover, the level of education of farmers is said to directly influence their capability to adapt to change and accept relatively new ideas (Adekunle, 2009). Furthermore Barrett et al. (2002) posited that farm-forestry practices, unlike conventional agricultural technologies, is more knowledge intensive and therefore farmer education is pivotal in encouraging adoption of farm-forestry.

Presence of off-farm income in a household can have a positive or negative effect on the adoption decision. This is because labour outside the farm may increase interaction with others and this may improve access to information on farm-forestry thereby facilitating the

adoption of the technology. Off-farm income can also enable adoption as it increases the capacity to finance investments in farm-forestry and facilitate acquisitions of essential inputs needed in farm-forestry. However, it may also have a negative effect as it might divert time and energy away from farming activities, thereby decreasing investments in innovations (Kassie et al., 2013).

Another important factor is contact with extension agents, which is anticipated to have a positive influence on adoption because extension agents avail information to farmers encourages adoption of an innovation. Due to the threats caused by climate change, farm-forestry has emerged as a climate smart practice that can help mitigate this global threat. Indeed farm-forestry not only benefits the adopting farmer but also provides positive externalities such as watershed preservation, enhancing biodiversity, and carbon sequestration that are not rewarded by the market mechanism. Therefore without Government intervening through creating incentives the level of adoption will be less than socially optimal (Mwase *et al.,* 2015).

But as Ajayi et al (2009) notes, government support for farm-forestry in terms of extension programs is low. An explanation given to this is the low government extension staff to farmer ratio in many Sub-Saharan countries; a situation which is usually solved through training of farmer trainers and farmer groups (Masangano and Mthinda, 2010; Franzel and Wambugu, 2007). Unfortunately some studies have established that agro-environmental practices such as farm-forestry are not adequately understood by extension workers and are less probable to be disseminated (Banful *et al.,* 2010). An explanation given for this is that farm-forestry is largely viewed by extension workers as the domain of foresters (Chitakira and Torquebiau, 2010).

Mwase et al, (2015) found out in their study of adoption of farm-forestry in Southern Africa that two top reasons for the failure to adopt farm-forestry by farmers were high input costs and lack of knowledge and skills on farm-forestry. The study further pointed out that the lack of knowledge was as a result of little extension contact. This is unfortunately because as Matata et al, (2010) argued that it is frequent extension contacts that enabled farmers to develop a favourable attitude towards farm-forestry which led to adoption. Furthermore, Adesina and Zinnah, (1993) argued that if an innovation is appropriate for farmers then in order to ensure it is adopted, the information on the technology should be communicated to the end users, mainly through extension, media and opinion leaders.

Some studies have noted that government support in different forms is always given to food crop but farm-forestry is not always included. In India for example, a study cited that credit facilities at subsidized rates were given for agriculture but not farm-forestry (Place et al., 2012). In addition in many countries governments had streamlined market information systems for agricultural products but there have been none for tree products (Place et al., 2012). On a more positive note, government support, commitment and finance for conservation agriculture with trees in Zambia led to impressive adoption levels by farmers. Also the Ethiopian Government was noted to have been active in encouraging adoption of farm-forestry through establishment of government nurseries and provision of subsidized seedlings so as to reduce the costs associated with the adoption (Place *et al.,* 2012).

The private sector has also played this role although their promotion is mainly for value chain development. In India for instance wood processing companies in Haryana State created awareness on the economic importance of timber trees to local farmers and even supplied seedlings (Zomer *et al.*, 2007). Fruit processing and exporting companies in Kenya have been cited as a contributing factor in the gradual adoption of fruit farming in Kenya through creating awareness and offering ready markets (Place et al.., 2012). In some cases NGOs have played an essential role in teaching farmers on the importance and benefits of farm-forestry and enabled adoption through setting up projects. For example, in Niger, the NGO-Serving in Mission started a project on the natural regeneration of trees on farms which became pivotal in creating awareness beyond the project area (Reij*et al.,* 2009).

A farmer's social network can also significantly influence a farmer's decision on whether or not to adopt a technology such as farm-forestry. This is because one of the barriers to the adoption of any agricultural technologies is informational asymmetry concerning the particular technology. Social capital refers to "the resources such as information, ideas, support that individuals are able to procure by virtue of their relationships with other people. "The structure of a given network—who interacts with whom, how frequently, and on what terms—thus has a major bearing on the flow of resources through that network" (Grootaert, Narayan, Nyhan, & Woolcock, 2004). Those who occupy strategic positions in the network, specifically those who have ties in important groups, can be said to have more social capital than their peers, as their position in the network increases access to more and better resources (Burt 2000).

Sabatini (2006) posited that social capital is acknowledged with social networks, which are comprised of: informal networks of strong families' ties (bonding social capital), informal networks of weak ties of friends and acquaintances (bridging social capital), and formal networks connecting members of voluntary organizations (linking social capital). Therefore social networks are seen as a means to obtain information and reduce information asymmetries among farmers (Fafchamps and Minten, 2002; Di Falco and Bulte, 2011). Other studies also linked the behaviour of farmers with the behaviour of their peers that the farmers themselves identified (Bandiera and Rasul 2006 and Maertens 2009).

Conley and Udry (2010) in particular observed that farmers changed their fertilizer input level when they got information on the fertilizer input levels used by their neighbours who had achieved better than expected production in previous harvest. They identified information spill overs between farmers through asking small-scale farmers if they had gone to each of seven randomly selected farmers in the same village for advice on farming. Bandiera and Rasul (2003) in their study of sunflower production in Mozambique pointed out that though social networks are an important factor in determining adoption and that they were more important for farmers who had less information in the absence of their network. They further stressed out that farmers' decision to adopt was indeed influenced by the decisions of others in their social network. But, they established that there were some that were more influenced by the decisions of their network than others, these farmers tended to be poorer and more vulnerable. Indeed adoption of new technologies is often perceived as a multi-dimensional process which involves the ability of new ideas to be communicated between adopters and potential adopters.

2.4 Farm-specific Socio-economic characteristics

Since farm-forestry is a long term investment, insecure land tenure has been cited by many researchers as a hindrance to its adoption. For instance (Oeba, Otor, Kung'u, & Muchiri, 2012) in their study of tree planting and retention in central province Kenya established that secure land tenure significantly influenced tree planting practices as tenants were less likely to adopt conservation practices that took longer period of times to realize the benefits. Otsuki (2010) also reaffirms this as land titles were found to significantly influence the adoption of farm-forestry in Laikipia and Suba districts in Kenya. Other studies also established the importance of secure land tenure in influencing farm-forestry adoption; for instance it was established that personal land ownership encouraged the adoption of farm-forestry in Western

Kenya, while other forms of land ownership such as rented or borrowed lands hindered the adoption of these practices because farmers could not use the land for long term production (Mugure, Oino & Sorre, 2013).

Agricultural enterprise such agro-pastoralism and mixed farming that involves the presence of livestock on the farm can either positively or negatively influence adoption of farm-forestry. Such enterprises have been shown by studies to have positive influence as farmers established fodder trees so as to supplement animal feeds (Wambugu, Franzel, Tuwei , & Karanja, 2001). However, negative effects also exist as livestock often feed on young trees making farm-forestry hard to practice (Sikuku, Apudo, & Ototo, 2014).

Farmers with larger farms are expected to plant more trees than those with smaller farms since the ones with smaller farms may prioritize on crop production. A study in western Kenya reported that trees occupied less than 10% of the land size due to small farm size as farmers prioritized food production over tree planting (Sikuku, Apudo, & Ototo, 2014). Moreover, larger land sizes were shown to positively influence tree planting and retention on farmlands in Central Kenya (Oeba, Otor, Kungu & Muchiri, 2012). Another study on the adoption of agro-forestry practices in Busia County, also established that as land size increased so did the acreage allocated to trees (Mugure, Oino & Sorre, 2013).

2.4 Psychological factors

There is consensus among social scientists that socio-economic characteristics are not the only determinants of adoption of technologies. Indeed social science researchers have long argued that farmers' perception and attitude towards a technology play an important role in influencing adoption. Adesina and Zinnah (1993) found that a farmer's perceptions of the attributes of modern rice varieties significantly affected adoption decisions in Sierra Leone. Furthermore a study on on-farm tree growing in the Western Himalayas found that attitudes towards tree growing were the second most important determinant of adoption (Sood and Mitchell 2004). This study applied the Theory of Planned Behaviour in measuring the psychological attributes of the respondents. The TPB tool has been applied by several studies to gain insightful understanding of farmers' decision to adopt a technology and the perception they may have towards the technology (Zubair, et al., 2011; Herath, 2013; Zubair & Garforth, 2006; Bond, Kriesmer, Emborg, & Chadha, 2005).

Theory of Planned Behaviour posits that performance of behaviour is determined by intention to perform that behaviour (Ajzen, 1991). Behavioural intention is theorized to be determined by attitude towards the behaviour, the subjective norms and the perception of behavioural control. Attitude in the context of TPB is "the degree to which an individual has a favourable or unfavourable evaluation of the behaviour in question" (Roca, 2011). The subjective norms are "the social pressure from important others (social networks) to perform or not to perform the behaviour while perception of behavioural control is the degree to which an individual feels that performance of the behaviour is under ones volitional control" (Ajzen, 1991; Zubair, et al., 2011). In the case of tree growing practices adoption farmers may perceive the presence of factors that inhibit or facilitate the planting of trees and which they consider makes farm-forestry either easier or more difficult to practice (Zubair & Garforth, 2006).

In their study of farmers' pesticide use, Bond, Kriesmer, Emborg, and Chadha, (2006) used the TPB tool and found it useful in investigating farmers' attitudes, subjective norms, perceived behavioural control and perceptions of pesticide use. Zubair and Garforth (2006) also used the TPB tool to explore the beliefs behind farmers' attitudes, to find out the role of subjective norms and the factors that enabled or disenabled the successful practice of tree growing. They found out that "decision whether to grow trees on farmland is influenced by a farmer's perception of the benefits and losses in engaging in farm-forestry" (Zubair & Garforth, 2006). They also discovered that pressure from social networks was an important element influencing farmers' adoption of farm-forestry. In a study of farm-forestry adoption by farmers in Malawi, the TPB tool was used to examine the influence of attitudes and adoption behaviour. The study found that respondents with more positive attitude towards farm-forestry reported to have planted trees on their land. Likewise respondents who experienced a more positive subjective norm also reported to have planted trees on their farm in the past five years (Meijer, Catacutan, Sileshi, and Nieuwenhuis, 2015).

Although researches on farm-forestry and agro-forestry have focused on the roles played by socio-economic factors such as age, gender, extension and education level on the adoption decision. Few studies have looked at the role that social capital can play in the adoption of farm-forestry practices. Moreover very few studies on the role of socio-economic factors on the adoption of farm-forestry have been carried out in Narok County. Furthermore, very few studies in Kenya have investigated the role of psychological factors on adoption of farm-

forestry. In addition the TPB tool has not been applied to any study on farm-forestry adoption in Kenya. This study therefore intends to fill this gaps.

2.5 Theoretical Framework

Theoretical framework for this study is based on a combination of two theories that explain the decision-making process. The first one is the innovation-diffusion theory also known as sociological theory of innovation-diffusion developed by Everret Rogers (Rogers, 2003). The diffusion of innovations theory identifies access to information as the key factor determining adoption decisions. Therefore the theory views the adoption of innovation by farmers as a learning process with two distinct aspects. One aspect involved the acquisition of information about the innovation to allow better decision making regarding the innovation. Before adoption of an innovation, farmers' uncertainty about the innovation is high and decision making is low but as more information is provided or sought, uncertainty is reduced and better decisions regarding the innovation are made (Marra et al. 2003). This aspect of the adoption or adoption process enables the farmer to decide on whether to adopt the technology or not. Indeed farmer characteristics such as extension contact and social networks can aid the access to the information that is needed to make an adoption decision. The other aspect is the improvement of the farmers' knowledge and skills in applying the skills to their situation. Indeed most agricultural innovations require acquiring the necessary knowledge and skills associated with the innovation before applying them therefore a farmer's knowledge of the technology is important.

The theory of planned behaviour (Ajzen, 1991), developed from the theory of reasoned action is a socio-psychological model. It theorizes that that performance of behaviour is determined by intention to perform that behaviour. The intention to perform behaviour is determined by the attitude towards the behaviour, the subjective norms and the perception of behavioural control. Attitude is the key focus in this theory and is conceptually defined as the "person's general feeling of favourableness or unfavourableness towards an object" (Zubair, et al., 2011).

Furthermore a person's attitude towards behaviour is influenced by his or her beliefs about the effects of performing the behaviour and an evaluation of the outcome of that behaviour. Subjective norms are a function of beliefs that are determined by social networks, that is: the person's beliefs that members of his/her social network would approve them performing the behaviour. Perception of behavioural control is the degree to which an individual feels that

the performance of the behaviour is under one's volitional control. It therefore, refers to skills, abilities, and opportunities on the part of individual that can enable or disenable the performance of behaviour. In this study this theory helped explain how attitude, subjective norms and perceived behavioural control influenced adoption of the farm-forestry policy. Subjective norm assessed the farmers' social network and whether or not they encouraged adoption of farm-forestry. While perceived behavioural control looked at factors outside the farmers' control that either enabled or hindered the adoption of the policy.

2.6 Conceptual Framework

Independent Variables

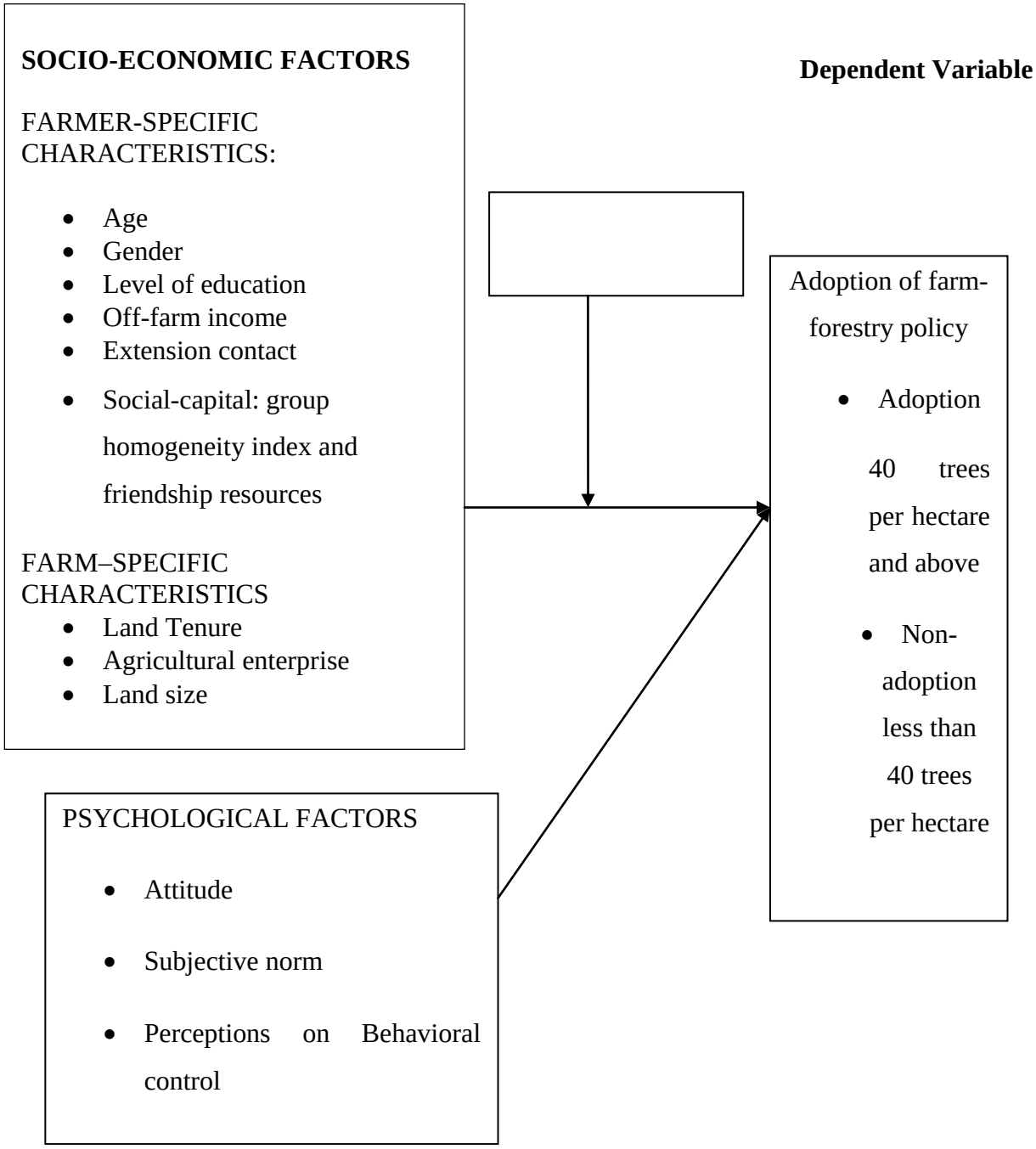

Figure 1: Conceptual framework of Factors influencing adoption of Farm- forestry

Source**:** Own Conceptualization

The independent variables for this study are the socio-economic characteristics measured in terms of farmer specific characteristics; the farm-specific characteristics and the psychological factors measured in terms of attitude, subjective norms and perceived behavioural control based on the TPB constructs. The dependent variable was the adoption of farm-forestry policy whose indicators were adoption when a farmer has established forty trees and more per hectare of land holding and non-adoption when a farmer has established less than forty trees per hectare of land holding. Establishing farm-forestry in this study included both planting trees and intentionally retaining naturally regenerating indigenous trees.

The conceptual framework for this study corresponded with the theory of innovation diffusion and theory of planned behaviour. This study measured adoption of farm-forestry using the guidelines in the farm-forestry rules of 2009 which stated that each person who owned or occupied agricultural land shall establish and maintain a minimum of 10% of the land under farm-forestry. However how to measure the size of land occupied by scattered trees, boundary trees and trees along riparian is not clearly spelt out in the guidelines, even though they are common farm-forestry practices in Kenya. This case raised the pertinent question on what was the appropriate cut-off point for delineating adopters and non-adopters of farm-forestry as per the farm-forestry rules of 2009 from a practical perspective.

Therefore this challenge was addressed by using the number of trees per hectare planted by a farmer to measure the attainment of the 10% tree cover as was easier to estimate. Using 5 meters by 5 meters spacing recommended for most arid areas, FAO (1989) recommended that a hectare of land should have a tree density of 400. The tree spacing for arid areas was deemed most appropriate as it took into account all the agro-ecological zones of the Sub-County. Therefore, taking the farm-forestry policy guideline of 10%, a farmer should have at least 40 trees per hectare in order to be considered a farm-forestry adopter.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The chapter focused on methodology that was used by the study. This chapter describes the research design was used, provides a description of the study area, target population, sample size determination, sampling procedures used, the research instruments, reliability as well as validity of research instruments, the data collection procedures that were followed as well as data analysis procedures and it finally closes with the ethical issues that were put into consideration during data collection.

3.2 Research Design

The study used an explanatory sequential mixed method research design. In this design, the researcher begins by conducting quantitative research, analysed the results and then explain them in a more detailed manner with qualitative data. It was considered explanatory because the initial quantitative data was explained and expounded on further by qualitative data (Creswell, 2014). It was also considered sequential because the qualitative phase was preceded by the initial quantitative phase. The design is usually popular in the fields with a strong quantitative orientation hence the project commenced with quantitative research. In this study, quantitative data was collected using questionnaires after which the results were analysed and then explained in more details by qualitative data collected through interviews schedules.

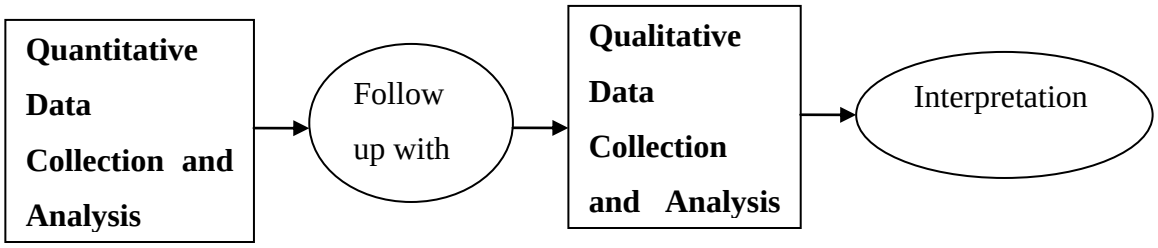

Figure 2: Explanatory Sequential Mixed Methods Research Design

Source: Creswell, 2014

3.3 Study Area

This study was done in Narok North Sub-County one of four Sub-Counties of Narok County, in the south eastern part of Kenya. The Sub-County has a total population of 118,923 persons at a density of 55 per square km and total number of households at 37,654. The Sub-County has six wards that are namely, Narok Town, Olposimoru, Olokurto, Melili, Oloropil and Nkareta (Narok County Intergrated Development Plan 2018-2022, 2018). The Sub-County has various climatic conditions and land-use types. The rainfall distribution is uneven but has a bi-modal pattern with two rainy seasons. The high altitude area is in the northern half of the Sub-County and receives a mean rainfall of 1000-1800mm per annum. The lower areas are drier and have been classified as semi-arid and receive 500mm of rainfall or less per annum. The high altitude areas of Narok north Sub-County mainly have large scale commercial farms and small scale mixed farming is mainly practiced in the mid elevations areas. In the lower drier areas a combination of pastoralism, small scale farming is mainly practiced and leasing for commercial wheat production is also practiced where suitable (Narok County Intergrated Development Plan 2018-2022, 2018). This study area was selected for its diverse agro-climatic zones, varied agricultural practices and its proximity to one of Kenya's largest water towers, the Mau Forest. Moreover, the Sub-County has been experiencing extreme climatic conditions over the last decade, with floods and drought being prevalent; a situation that is said to be caused by the high deforestation rates in the area.

The map of the study area is as shown in figure 3 below:

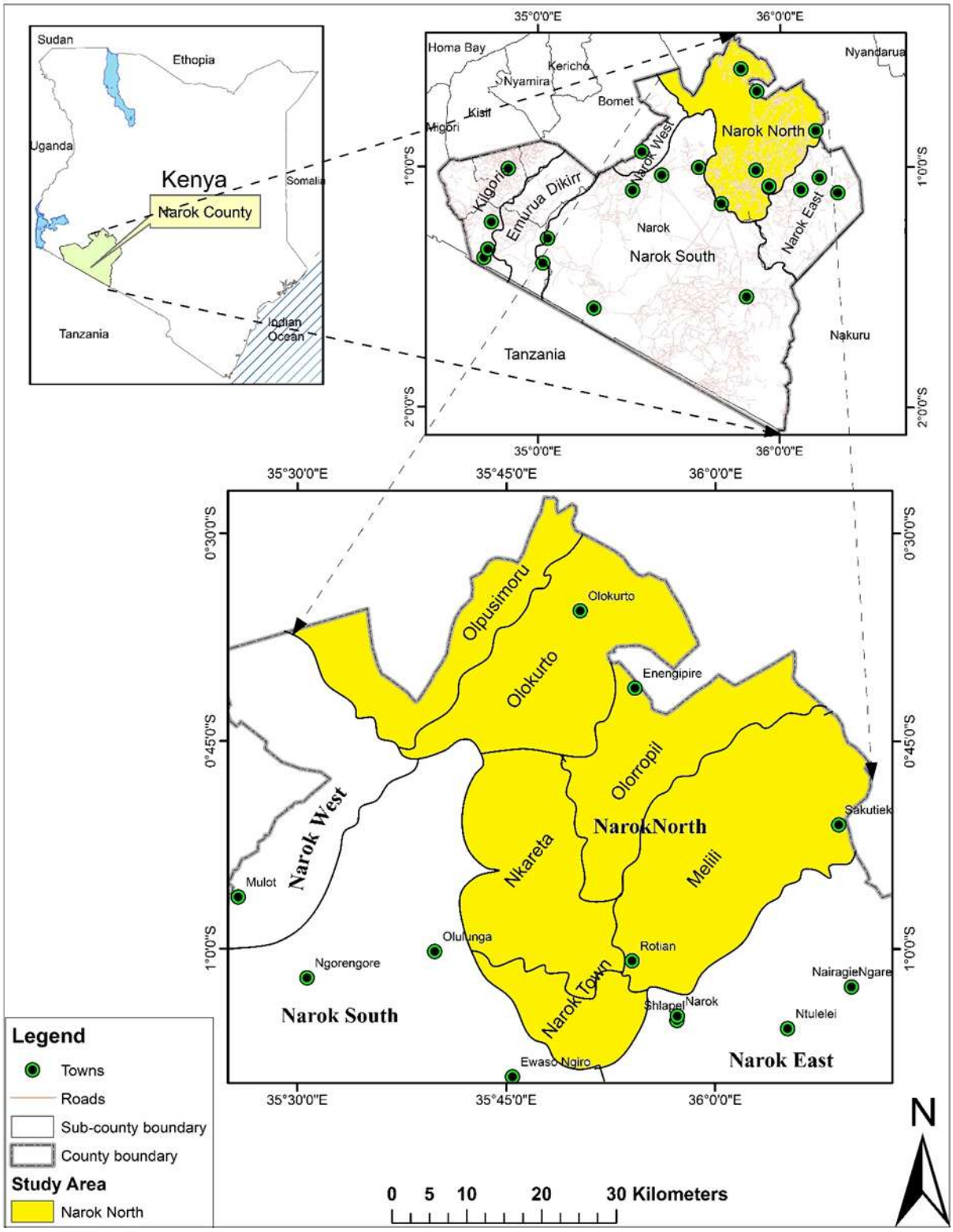

Figure 3: Map of the study area

Source: Narok County Integrated Development Plan (2018-2022), 2018

3.4 Population of the Study, Target population and Accessible Population

In this study the population of interest was small-scale farming households in Narok North Sub-County. These were farmers who owned between 0.4 hectares and 20 hectares of farmland, this included pastoralists, agro-pastoralists and crop farmers. The population of households in Narok North Sub-County is 37,654 (KNBS & SID, 2013).

The target population for which the findings are generalizable is 163,823 farming households in Narok County (KNBS & SID, 2013). The accessible population for this study was 25,014 farming households in the five farming wards of Narok North Sub-County (KNBS & SID, 2013). Narok town ward was purposively excluded in this study due to its largely urban population as the study targeted farming households.

3.5 Sampling Procedure and Sample size

This study used a two stage sampling procedure whereby the first stage was proportionate sampling and the second stage was simple random sampling. Based on a report on inequality in Kenya by the Kenya National Bureau of Statistics (KNBS), the population of households in the five selected wards in Narok North Sub-County was 25,014 (KNBS; SIDA, 2013). The sample size was calculated according to Nassiuma's (2000) using the following equation;

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

$$n = \frac{25014 \times 0.21^2}{0.21^2 + (25014-1)0.02^2}$$

$$n = \frac{1103.1174}{0.0441 + 10.0052} = \frac{1103.1174}{10.0493}$$

$$n = 109.770571$$

Therefore the sample size was 110 small scale farm households. Where N is the population of study, C is the coefficient of variation which should be ≤ 30%; was chosen and e is margin of error which is fixed between 2-5%).

The study sample was calculated with the household population size of 25,014 at 21% coefficient of variation and 2% margin of error (Nassiuma, 2000) and this resulted in a sample size of 110 households. 21% coefficient of variation was used to ensure that the sample was wide enough to justify the results being generalized for Narok County. Higher

coefficients of variation were not used to avoid very large samples due to limitation of research funds.

Proportionate sampling was used to apportion sample sizes across the five farming wards in the Sub-County according to the population of the wards. In the second stage simple random sampling was carried to obtain farm-forestry adopters and non-adopters from the small-scale farming households in the five farming wards.

Purposive sampling was done for the qualitative research whereby 10 farm-forestry adopters who had the highest tree densities and 10 non-adopters who had the lowest tree densities were purposively selected from a sampling frame of 110 respondents who participated in the quantitative research.

Table 3.1: Proportional Sample Sizes across the Farming Wards

Ward	Household population (hhpop)	Sample (Hhpop/total pop*sample size)
Olposimoru	3,666	16
Olokurto	3,781	17
Nkareta	3,850	17
Oloropil	6,222	27
Melili	7495	33
Total	25014	110

3.6 Instrumentation

The instruments that were used for this study are the structured questionnaire and interview guides. The structured questionnaire was used to collect data on factors that influenced adoption from both farm-forestry adopters and non-adopters while interview guides were administered to selected individuals to gain in-depth insight on the adoption of farm-forestry practices.

3.6.1 The structured questionnaire

A structured questionnaire was used to collect quantitative data from 110 small scale farmers, in this study only household heads were interviewed. The questionnaire was administered to the household heads by the researcher with the help of research assistants. The items on the questionnaire were based on the objectives; some were also adapted from social capital integrated questionnaire and from the Theory of Planned Behaviour constructs. The first part

of the questionnaire were questions on the socio-economic characteristics of interest, both farmer-specific and farm-specific characteristics, questions on farmer group membership, farmer group characteristics, network resources were also asked to measure the social capital dimensions. The second part of the questionnaire was on the adoption of farm-forestry; this was measured on the basis of trees per hectare of land owned. The third and final part of the questionnaire had questions on the psychological factors. The researcher used the TPB constructs as suggested by Ajzen (2006) to measure attitude, subjective norm and perceived behavioural control; likert scales were used to measure the different components of TPB constructs.

3.6.2 Interview guides

Interview guides were used to collect qualitative data from farm-forestry policy adopters and non-adopters who were chosen based on high adoption levels of farm-forestry and non-adoption respectively. The adopters that were interviewed were those with the highest tree density and this was done to explore more on their social economic and psychological factors that influenced adoption of farm-forestry. The non-adopters that were interviewed were those with the lowest number of trees per hectare or those who had not planted trees at all. This was done to investigate more on the socio-economic and psychological factors that hindered adoption of farm-forestry.

3.7 Validity

To guarantee the validity of the research instrument, the research instruments were given to the research supervisors and policy research experts from Egerton University for judgement. The instruments were checked for face and content validities and were modified according to the suggestions given by the supervisors and the experts.

3.8 Reliability

To test the internal consistency of the items recorded on the research instrument, the Cronbach alpha coefficient was computed using SPSS Software. The Cronbach's Alpha is a numerical coefficient of reliability and is used to describe the reliability factors extracted from a dichotomous and or multipoint formatted questionnaire. A pilot survey was carried out in Narok East Sub-County with 10 farming households. This Sub-county was chosen for piloting as its population characteristics closely resembled those of the study area. Cronbach’s alpha was used to test reliability of the questionnaire that was used in the study. It

yielded a correlation coefficient of 0.79 and this was considered acceptable (Mugenda & Mugenda, 2003).

3.9 Data Collection Procedure

This study used primary data that was collected from respondents in Narok-North Sub-county. The researcher sought an introductory letter from Egerton University Graduate School to assist in obtaining a research permit from the National Commission of Science, Technology and Innovation (NACOSTI). The researcher then visited Narok County Commissioner's office to inform the officials of the intention to collect data within Narok North-Sub-County. A set of 110 questionnaires were administered to the respondents who were small-scale farmers from the five wards of Narok North Sub-County. The questionnaires were administered by the researcher and a team of research enumerators so as to take into consideration respondents who could not read or write. Qualitative data was collected through interview guides with farm-forestry policy adopters with very high tree density levels and non-adopters with very low to zero trees per hectare.

3.10 Analytical framework

The quantitative was first collected and then the qualitative data was collected as per the explanatory sequential mixed method research design. The qualitative data was entered into SPSS and coded and cleaned before it was imported to STATA and Excel for analysis. While the qualitative data was transcribed in Microsoft word before thematic content analysis using thematic networks was carried out. Below is a detailed description of how each objective in the quantitative study was analysed.

Objective 1: To determine the influence of farmer-specific socio-economic characteristics on the adoption of farm-forestry policy in Narok North Sub-County, Kenya. For this objective Chi square and fisher's exact tests were carried out in STATA to test the relationship between the categorical farmer specific characteristics such as gender, extension contact, farmer group membership, age-group and off-farm income and the adoption of farm-forestry. The social capital dimensions for farm-forestry adopters and non-adopters were first generated into scores using PCA before their means were tested using t-tests. The number of schooling years was also tested using t-test to find out if there were significant differences between the adopters and non-adopters.

Objective 2: To determine the influence of farm-specific socio-economic characteristics on the adoption of farm-forestry policy in Narok North Sub-County, Kenya. Here Fisher's exact test in STATA was used on the categorical farm-specific characteristics. Fisher's test is analogous to chi-square test and is used when the cells in the table consist of small frequencies such as was the case in age groups, land tenure status and agricultural enterprises. T-test was used to test for significant differences in land size between the adopters and non-adopters of farm-forestry.

Objective 3: To compare the psychological factors of adopters and non-adopters of farm-forestry policy in Narok North Sub-County, Kenya. In this objective, median values and Mann-Whitney U tests using SPSS were used. The median values for the different likert items were compared for the farm-forestry adopters and non-adopters. The Mann-Whitney test was used to test for significant differences in the median values of farm-forestry adopters and non-adopters. The Mann- Whitney U-test is a non-parametric test analogous to t-tests, however in contrast to the t-test; it does not compare mean scores but median scores of two samples. Mann-Whitney U tests were carried out separately for attitude towards farm-forestry, social norms and perceived behavioural control. T-tests were also carried out for the attitude index, subjective norms index and PBC index to test for significant differences among the farm-forestry adopters and non-adopters.

Objective 4: To determine which socio-economic and psychological factors predicted small-scale farmers' adoption of farm-forestry policy in Narok North Sub-County, Kenya. Tobit regression model is the empirical model that was used in this study and was applied to this objective. The application of Tobit model was preferred in this study because it uses data at the limit as well as those above the limit to estimate the regression. The cut point adopted lead to mass clustering of values of the dependent variable, (number of trees per hectare) around the censoring value and thus the censoring of censoring data made the Tobit model appropriate. As explained earlier adopters were defined as farmers with 40 trees and more per hectare, those who had less were classified as non-adopters. This study had only a lower censoring point in which those who had less than 40 trees were censored while those with 40 trees and above were uncensored and their socioeconomic and psychological characteristics were used to predict the regression model.

Tobit model has over the years been used in many adoptions studies such as Adesina and Zinnah, 1993; Holloway et al., 2003; Adesina, Mbila, Nkamleu, & Endamana, 2001) This study considered the standard Tobit model as explained by Carson and Sun (2007).

Where y_i^* is a latent response variable, X_i is an observed 1 × k vector of explanatory

$$y_i^* = \alpha + X_i\beta + \varepsilon_i \quad \text{.....3.1}$$

variables, and ε_i is the error term and is independent of X_i. Instead of observing y_i^*, we observe yi:

$$y_i = \begin{cases} y_i^* & y_i^* \geq \gamma \\ 0 & y_i^* < \gamma \end{cases} \quad \text{if,} \quad \text{where } \gamma = 40 \text{ trees per hectare}$$

Therefore, the Tobit model examines the adoption of farm-forestry as a function of the socio-economic characteristics and psychological factors. Adoption of farm-forestry is measured by the number of trees per Hectare (NTH) and is a function of the variables as depicted by the empirical model below:

$$NTH = \alpha + \beta_1 Age + \beta_2 Gender + \beta_3 Educ + \beta_4 Grp + \beta_5 Extension$$
$$+\beta_6 Landtenure + \beta_7 Landsize + \beta_8 Attitude + \beta_9 Subnorm + \beta_{10} PBC + \varepsilon_i$$

For this study the number of trees per hectare (NTH) was the dependent variable. Age, gender, education level, extension, land tenure, land size, attitude, subjective norm and PBC were the independent variables. Table 3.2 below shows the description of variables used in the Tobit model while table 3.3 gives a summary of the analytical procedures that were applied on the hypotheses of the study.

Table 3.2: Description of variables used in the Tobit model

Dependent Variable		
Adoption of Farm-forestry	Number of trees per hectare, 40 trees and above = adoption 39 trees and below = non-adoption	
Independent Variables		**Expected sign**
Age	Age group of the farmer measured in age brackets	+ -
Gender	Measured in binary 1= male 0 = female	+ -
Extension contact	Contact with extension agents measured in binary 1= yes, 0 otherwise	+
education	Level of education of household head	+
Farmer group membership	Membership in farmer group measured in binary 1= yes, 0, otherwise	+
Land size	Measured in hectares	+
Land tenure	Measured in binary 0 = accessed but not owned 1= accessed and owned	+ -
attitude	Farmers attitude towards farm-forestry, measured in a continuous index obtained by summing the product of belief strength and outcome evaluation	+
Subjective norm	Measured as a continuous index obtained by summing the product of normative belief and motivation to comply	+
Perceived behavioural control	Measured as a continuous index were calculated by summing the products of control beliefs and the power of control beliefs	+

3.11 Qualitative data analysis

Qualitative data was collected using interview guides and analysed using thematic content analysis. The number of farmers that participated in the in-depth interviews was 20 in total consisting of 10 adopters and 10 non-adopters. The first objective of the qualitative research was to find out the opinions of farm-forestry adopters and non-adopters about the practice of farm-forestry. The second objective was to find out the challenges the adopters faced in their

practice of farm-forestry. This objective also involved discovering the hindrances the non-adopters encountered that prevented them from adopting farm-forestry. And finally the third objective aimed at finding out the skills and knowledge farm-forestry adopters and non-adopters possessed with regard to farm-forestry. The analysis of the three objectives were aided and presented using thematic networks, a form of thematic content analysis that involved generating themes from texts at three different levels. In the first level basic themes were generated from the texts in the transcripts, the second level involved grouping together related basic themes to generate organizing themes and final the third level consisted of global themes that were obtained by grouping together related organizing themes. The global themes summarized the main themes and gave a general picture of the ideas and opinions of the respondents with regard to the questions asked. The use of thematic networks has been lauded as robust and a useful tool for the analysis and presentation of qualitative data (Attride-Stirling, 2001).

Table 3.3: Summary of Quantitative Data Analysis

Hypotheses	**Independent Variable**	**Dependent Variables**	**Statistical Procedures &Tests**
H_O1 Farmer-specific socio-economic characteristics do not significantly influence the adoption of farm-forestry policy in Narok North Sub-County, Kenya.	Farmer-specific and farm specific characteristics	Adoption of farm-forestry	Frequencies, percentages Chi square, test fisher's exact test, t-tests, PCA
H_O2 Farm- specific socio-economic characteristics do not significantly influence the adoption of farm-forestry policy in Narok North Sub-County, Kenya.	Farm-specific characteristics	Adoption of farm-forestry	Frequencies, percentages Fisher's exact tests, t-test
H_O3: There is no statistically significant difference in the psychological factors of adopters and non-adopters of farm-forestry in Narok North Sub-County, Kenya.	Psychological factors	Adoption of farm-forestry	median, Mann-Whitney U test, t-test
H_O4: Socio-economic and psychological factors do not significantly predict small-scale farmers' adoption of farm-forestry policy in Narok North Sub-County, Kenya	socio-economic and psychological factors	Adoption of farm-forestry	Tobit regression model

3.12 Ethical consideration

The study was conducted in accordance with the standard research ethics. The respondents were informed about the study that they were participating in and then informed consent was sought from the respondents prior to data collection whereby the respondents were free to decide whether or not they wanted to participate. During and after data collection anonymity and confidentiality was upheld. Informed consent and appointments for in-depth interviews for respondents were also sought.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter begins with the socio-demographic characteristics of the respondents presented in section 4.2, followed by section 4.3 which presents farmer-specific characteristics that influence adoption of farm-forestry. Section 4.4 presents farm-specific characteristics that influence adoption of farm-forestry. Section 4.5 presents descriptive and inferential results of the psychological factors of farm-forestry adopters and non-adopters while section 4.6 presents Tobit results of the influence of socio-economic characteristics and psychological factors on the adoption of farm-forestry. Finally Section 4.7 presents the qualitative analysis of the interview guide and the discussions therein.

4.2 Socio-demographic characteristics of the respondents

A majority of the respondents (28.2%) were between 50 and 59 years while the rest were distributed across the other age groups with a minority being at 70 years and above (3.6%). Furthermore a majority of the respondents were male household heads at 78.2% and while females household heads were 21.8%. an analysis of the the education level of the respondents indicated that those with no formal education stood at 9.1% while those with post-secondary education at 19.1% with the majority were the ones having only primary school education at 33.6%.

4.3 Farmer- specific socio-economic characteristics that influence adoption of Farm-forestry

This section presents the results of analyses that tested the influence of farmer-specific characteristics on the adoption of farm-forestry. The farmer-specific characteristics of interest were both categorical and continuous whereby chi-squares and fishers exact tests were used to test the categorical characteristics while t-tests were used on the continuous characteristics.

This study established that 52.7% (58) of the sample households were farm-forestry adopters while 47.3% (52) were non-adopters. Majority of the adopters were within the ages of 50-59 at 41.4% while the majority of non-adopters were between the ages of 20-29 at 34.6%. The results of the fisher's exact test indicated that there was a statistically significant relationship between farmers' age group and adoption of farm-forestry (fishers exact test value=36.73, ρ= 0.00).

This study established that in this study area older farmers adopted farm-forestry practices more than younger farmers. This results stand out from previous literature that posited that younger farmers are expected to practice farm-forestry more than older farmers. The probable explanation for the low levels of adoption of farm-forestry by among younger farmers in this study could be their land tenure status in which a majority of the young farmers reported although they had access to land they still lacked ownership as the land still belonged to their parents. Whereas the older farmers in the study mentioned that they had both access and ownership of land. Another explanation for the low adoption rate among younger farmers is the fact that older farmers have more farming experience and may therefore be using farm-forestry as a way of diversifying farm income or mitigating land degradation.

Furthermore it can be posited that younger farmers may be more motivated by farming investments that offer quick returns as opposed to long-term investments such as farm-forestry. Therefore, younger farmers in the sub-county should be given consideration in training on farm-forestry in order to adopt the policy. Table 4.1 shows the distribution of adopters and non-adopters across age-groups.

Table 4.1: Distribution of non-adopters and adopters across the age-groups

Age groups	Non-adopters (n)	Adopters (n)	Non-adopters (%)	Adopters (%)
20-29	18	0	100.00	0.00
30-39	17	9	65.38	34.62
40-49	5	16	23.81	76.19
50-59	7	24	22.58	77.42
60-69	4	6	40.00	60.00
70+	1	3	25.00	75.00

Descriptive statistics results showed that 89.7% of the households that had adopted farm-forestry were male headed while only 10.3% were female headed households. The Chi square results further revealed there was a statistically significant relationship between gender of the household head and the adoption of farm-forestry ($\chi 2= 9.47$; $\rho=0.002$). It is clear that female-headed household are not adopting the policy as compared to their male counterparts. This is consistent with studies that showed that the average female-headed households are less likely to practice farm-forestry as compared to the male-headed farm households (Thangata & Alavalapati, 2003; Sanchez & Jama, 2002).

A possible reason for this according to literature is that women have heavier workloads and time poverty due to years spent on reproductive responsibilities and possibly also their higher risk aversion towards technology adoption, like that of farm-forestry (Kiptot & Franzel, 2011). Land tenure may also be disadvantaging women, for instance the lower adoption of farm-forestry by women in Western Uganda was due to the lack of secure land and tree tenure by women caused by the existence predominantly patrilineal inheritance systems (Thangata and Alavalapati, 2003).

In other cases gender has also been posited to influence adoption of agricultural technologies indirectly through the acquisition of information as some studies have established that male-headed household are more likely to easily access information about new technologies than female-headed households (Asfaw and Admassie, 2004). This can be the case here as farm-forestry is knowledge and resource intensive thus female headed households could be facing constraints that make it difficult for them to adopt the policy.

The results further indicated that 58.6% of farm-forestry adopters said that they received some form of extension advice or training while only 13.5% of farm-forestry non-adopters indicating that they also received extension advice. Moreover there was a statistically significant relationship between extension contact and the adoption of farm-forestry ($\chi 2= 23.96$; $\rho= 0.00$). These findings reflect Matata et al, (2010) argument that it is frequent extension contacts that enabled farmers to develop a favourable attitude towards farm-forestry which lead to adoption. Furthermore, Adesina and Zinnah, (1993) stated that if an innovation is appropriate for farmers then in order to ensure it is adopted, the information on the technology should be communicated to the end users, mainly through extension, media and opinion leaders. Extension contact has indeed been proven to be important in helping farmers adopt the policy as they are made aware of the importance of planting trees and the type of species to plant. Furthermore, extension officers act as sources of information and provide farmers with knowledge and skills needed to adopt farm-forestry practices.

The number of adopters who indicated that they belonged to one or more farmer groups was at 74.1% while 36.5% of non-adopters said they belonged to a farmer group. The results show that there was a statistically significant relationship between membership to a farmer group and adoption of farm-forestry ($\chi 2=15.76$; $\rho= 0.00$). Membership to groups therefore, is an important factor in the adoption of the farm-forestry policy. This can be attributed to the fact that groups act as sources of information and influence as farmers exchange ideas and

also influence one another. It is also through groups that farmers can receive trainings on various issues including agro-environmental issues. Groups create social capital in that members of the group are privy to information, knowledge and other resources needed to adopt a technology.

There was a statistically significant difference between the education level of farm-forestry adopters and non-adopters. ($t=2.99$, $\rho= 0.00$). This corroborates with findings by Thangata and Alavalapati, (2003) also revealed that education was positively associated with probability of adopting farm-forestry practices. A possible explanation for this is that education influence adoption of farm-forestry indirectly by increasing the capability of farmers to utilize their resources efficiently and improved farmer's capacity to obtain, analyse and interpret information (Amaza and Tashikalma, 2003). Moreover, the level of education of farmers is said to directly influence their capability to adapt to change and accept relatively new ideas (Adekunle, 2009). Furthermore Barrett et al. (2002) posited that farm-forestry practices, unlike conventional agricultural technologies, is more knowledge intensive and therefore farmer education is pivotal in encouraging adoption of farm-forestry. Therefore a farmer's educational level is pivotal in the adoption of the farm-forestry policy.

Social capital was posited by this study to be significant in influencing the adoption of farm-forestry. The social capital dimensions used for this study were group homogeneity index, group density and friendship resources score. Farmers' groups were assed for homogeneity using questions on the diversity of group members in terms of their gender, education level, ethnicity, religion and occupations. Each farmer who belonged to a group was asked whether members of their main group were of the same gender, education level, ethnicity, religion and occupations. The groups were also assessed to what degree they interacted with other groups with the village, with other groups outside the village and with NGOs and government institutions. The responses were captured in binary form yes = 1 and no = 0 and then analysed with PCA in STATA, to generate single weighted scores for each farmer who belonged to a group.

The analysis first generated a matrix and the components were then rotated using the orthogonal varimax (Kaiser off) technique to standardize the coefficients. The first three components had eigenvalues greater than one which meant they accounted for most of the variances. Two of the components with the highest eigenvalues were selected and their variables were then used to predict the homogeneity indices. The predicted indices from

component one was used in this study as it best represented the data collected. Tables 4.2 and 4.3 shows the results of the PCA and the variables used to calculate the homogeneity indices.

Table 4.2: Components and eigenvalues for groups' homogeneity indices

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.54	1.09	0.32	0.32
Comp2	1.44	0.38	0.18	0.50
Comp3	1.07	0.26	0.13	0.63
Comp4	0.81	0.13	0.10	0.73
Comp5	0.68	0.07	0.08	0.82
Comp6	0.61	0.14	0.07	0.89
Comp7	0.47	0.09	0.05	0.95
Comp8	0.38		0.04	1

Table 4.3: Variables and eigenvectors for the first two components

Variable	Comp1	Comp2
are the group members of the same religion	0.41	-0.28
are the group members of the same gender	0.44	0.30
are the group members of the same ethnic group	0.44	0.19
are the group mostly of similar occupation	0.39	0.27
are the group members generally of the similar education level	0.30	0.22
does the group interact with other groups village	-0.05	0.48
does the group interact with other groups outside this village	-0.27	0.62
does the group interact with government institutions or NGOs	-0.34	0.23
Principal components (Eigenvector)		

The friendship resource was assed using five statements which centred on the use of friendship to access information and resources used in farming and in farm-forestry. The statements were measured on a five point likert scale and the responses were analysed using PCA which generated weighted scores for each farmer. The first two components had eigenvalues greater than one which meant they accounted for most of the variances. The two components were then selected and their variables were used to predict friendship resource scores. After the friendship scores were predicted from the two component, the scores that best explained the data was selected, in this case the predicted scores from component one

were selected. Tables 4.4 and 4.5 below show the results of the PCA and the variables and Eigen factors used to predict the friendship scores.

Table 4.4: Components and eigenvalues for friendship resources score

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.92	1.60	0.58	0.58
Comp2	1.32	0.96	0.26	0.85
Comp3	0.35	0.13	0.07	0.92
Comp4	0.23	0.05	0.05	0.96
Comp5	0.18	.	0.04	1

Table 4.5: Variables and eigenvectors for the first two components of the PCA

Variable	Comp1	Comp2
I have gained resources through my network of close friends	0.49	-0.29
I have gained information and knowledge through my network of close friends.	0.49	-0.37
My network of close friends provides me with access to my close friends farming experience and 'know-how'	0.49	-0.25
I have mostly learned about farm-forestry from my network of close friends	0.39	0.57
My network of close friends has influenced my adoption of farm-forestry	0.36	0.62

Group density was measured by the number of groups each farmer belonged to; with those belonging to more groups having higher group density.

T tests were then carried out to test for statistically significant differences in the homogeneity indices of farm-forestry adopters and non-adopters, their friendship scores as well as their group density. As table 4.6 below shows, the two groups exhibited statistically significant differences in the above social capital dimensions. Farm-forestry adopters had a significantly higher group density ($t=-2.89$, $\rho= 0.05$) and friendship score ($t=-11.78$, $\rho= 0.00$), but a significantly lower group homogeneity index ($t=3.43$, $\rho= 0.05$). These results corroborate with the literature on social networks and social capital which posit that farmers with more

social networks have easier access to agricultural information and thus are more likely to adopt agricultural technologies (Fafchamps and Minten, 2002; Di Falco and Bulte, 2011). Higher group density implies that farmers have access to a wider variety of information and knowledge resources and this could explain their inclination towards adoption of farm-forestry. The diversity in information is also aided by the heterogeneous groups which ensure that farmers have access to varied information on agricultural technologies. Likewise the high score for friendship resources is an indication that famers are using their close social ties as means to gain resources and information. This corroborates with literature that showed farmers were influenced by the farming practices of their peers (Bandiera and Rasul 2006; Maertens 2009). Indeed, most farm-forestry adopters indicated that they learned the practice from close friends and families proving that close social ties also played an important role in disseminating farm-forestry technologies. Table 4.6 below shows the differences in the means of social capital dimensions of farm-forestry adopters and non-adopters.

Table 4.6: Differences in the means of social capital dimensions of farm-forestry adopters and non-adopters in Narok North Sub-County

Social capital dimensions	Adopters	Non-adopters	t-values	p-value
Group density	1.26	1	-2.89**	0.03
Group homogeneity index	0.21	0.48	3.43**	0.02
Friendship score	4.19	2.47	-11.78***	0.000

*** Significant at 1% level ** significant at 5%

4.4 Influence of Farm-specific Socio-economic characteristics on the adoption of farm-forestry

Most of the land in the study area was privately owned by individuals and the researcher did not encounter any respondents living on communal land. Two types of land tenure were identified: accessed but not owned and accessed and owned. Overall 24.5% of the sampled households accessed land through family affiliation but did not yet own land. The findings revealed that among respondents who had had access and ownership of land, 75.5% were farm-forestry adopters while 48.1% were non-adopters. Moreover, there was a statistically significant relationship between land tenure and adoption of farm-forestry (fishers exact test value=39.912, ρ= 0.00).

These findings are similar to Otsuki (2010) whose study found land titles significantly influenced the adoption of farm-forestry in Laikipia and Suba districts in Kenya. Likewise, (Oeba, Otor, Kung'u, & Muchiri, 2012) in their study of tree planting and retention in central province Kenya established that secure land tenure significantly influenced tree planting practices as tenants were less likely to adopt conservation practices that took longer period of times to realize the benefits. The reason for this as explained by Mugure et al (2013) is that the practice of farm-forestry is hinged on the right of a farmer to plant and use trees which in turn depended on the type of land tenure one had. In this case tree tenure and land tenure are interdependent and secure land tenure ensures tree tenure. Moreover, secure land tenure is crucial for any long-term investment such as farm-forestry and other sustainable land use practices. Table 4.7 below shows the relationship between land tenure and adoption of Farm-Forestry policy.

Table 4.7: Relationship between Land tenure and Adoption of Farm-Forestry Policy

Land tenure status	Non-adopter (n)	Adopters (n)	Non-adopters (%)	Adopters (%)	Fishers exact test value	Degree of freedom	P-value
Accessed but not owned	27	0	100.00	0.00	39.91***	1	0.00
Accessed and owned	25	58	30.12	69.88			

The agricultural enterprises practiced in the study area were categorized into three namely; crop farming, pure pastoralism and crop-livestock farming. Overall 90% of the households practiced crop-livestock farming, 5.5% practiced pure pastoralism while 4.5% practiced crop farming. There was also a statistically significant relationship between agricultural enterprise and farm-forestry adoption ($\chi 2=9.64$, $\rho= 0.00$). Such enterprises have been shown by studies to have positive influence as farmers established fodder trees so as to supplement animal feeds (Wambugu, Franzel, Tuwei & Karanja, 2001). Thus farmers with a crop-livestock enterprise may be more motivated to plant trees to improve crop production as well as have feeds for livestock.

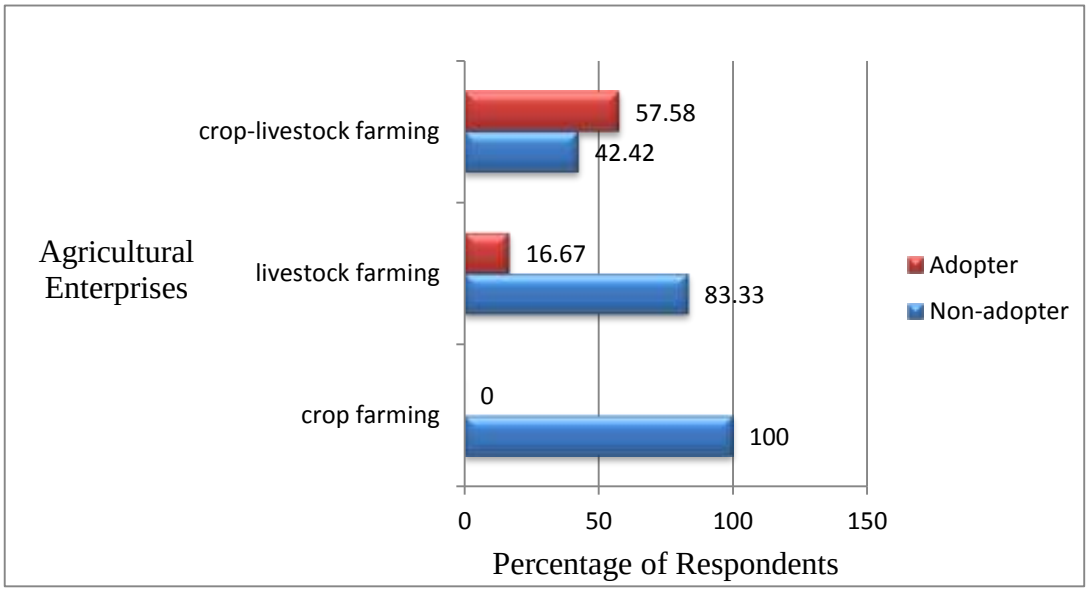

Figure 4: Adoption of Farm-forestry across Agricultural Enterprises

The mean land size for farm-forestry adopters was 6.94 hectares (17.16 acres) while that of non-adopters was 4.94 hectares (12.21 acres). The t-test results indicated there was a statistically significant difference between the two groups (t=0.016, ρ= 0.05). These findings concur with Oeba et al (2012) who found that land size significantly influenced tree planting and retention in Central Kenya. Similarly a study in Western Kenya by Mugure, Oino & Sorre (2013) found that as land size increased so did the acreage under trees. Thus bigger land sizes ensure that trees does not compete with crop production for land as most farmers tend to rationally prioritize crop production and food security.

Table 4.8: Differences in means of land size among farm-forestry adopters and non-adopters

Variable	Adopters	Non-adopters	t-test value	P-value
Land size (hectares)	6.94	4.94	2.44	0.02

4.5 The psychological factors of adopters and non-adopters of farm-forestry

The theory of planned behaviour constructs were used in this study to understand the rationality that underlies a farmer's decision to engage or not to engage in farm-forestry. These constructs included the farmer's attitude, subjective norm and perceived behavioural control. All the variables were measured on an ordinal scale which was a five-point likert scale. Since the data obtained were ordinal in nature, using the mean as the measure of central tendency was not appropriate and meaningful. Therefore for descriptive statistics median was used as a measure of central tendency while Mann-Whitney U test was used for inferential

statistics as it tested significance differences between median answers of farm-forestry adopters and non-adopters.

To measure respondents' attitude towards farm-forestry both positive and negative beliefs about the perceived consequences of farm-forestry were asked to the respondents. On the positive beliefs most of the adopters strongly agreed on the positive consequences of farm-forestry such as increasing income, increasing availability of firewood and furniture wood, control erosion, increase soil fertility. The majority of the adopters also disagreed on the negative beliefs of farm-forestry. This indicated that farm-forestry adopters had a more positive attitude towards farm-forestry since they strongly believed in the positive outcomes of farm-forestry and they did not belief in the negative outcome of farm-forestry.

While majority of farm-forestry non-adopters agreed on the positive outcomes of farm-forestry. The majority also agreed to two negative statements on farm-forestry, these were "planting trees on their farms will incur more costs" and "planting trees on their farms will increase pest outbreaks". Generally both farm-forestry adopters and non-adopters believed in the positive outcomes of farm-forestry with the adopters having a slightly stronger believe than the non-adopters. However the negative outcomes of trees were recognized with the non-adopters having a stronger belief in them as compared to the adopters.

Mann-Whitney U test was carried out on the salient beliefs that measured attitude, The U-test is a non-parametric test, in contrast to the t-test; it does not compare mean scores but median scores of two samples. Table 4.9 below presents the results of the median values and Mann-Whitney U test. The results of the U test indicated that there were statistically significant differences in the median scores of the belief strength among adopters and non-adopters of farm-forestry. Farm-forestry adopters and non-adopters differed in all the 13 salient beliefs on the outcomes of farm-forestry. With regards to the outcome evaluation of the salient beliefs, statistically significant differences were also seen in all the 13 salient beliefs at.

Table 4.9: Median and Mann-Whitney U test results for Attitude

Salient beliefs	Belief strength			Outcome evaluation		
Planting trees on my farm will…	FF Adopters Median	FF non-adopters Median	Significance (Mann-Whitney U test)	FF Adopters Median	FF non-adopters Median	Significance (Mann-Whitney U test)
Increase my income	5	4	0.00***	5	4	0.00***
Increase availability of fuel-wood and furniture-wood	5	4	0.00***	5	4	0.00***
Control soil erosion	5	4	0.00***	5	4	0.00***
provide shade for humans and animals	5	4	0.00***	5	4	0.00***
Is an important source of fruits for my family	5	4	0.00***	5	4	0.00***
Improve soil fertility	5	4	0.00***	5	4	0.00***
Cause hindrances to agricultural activities	2	2	0.00***	3	2	0.00***
Will incur more costs	2	4	0.00***	3	2	0.00***
Cause shade that will reduce crop yield	2	2	0.00***	3	2	0.001***
Increase pest outbreaks	2	4	0.00***	3	2	0.00***
Take up too much space	2	2.5	0.00***	3	2	0.00***
Lead to water scarcity	2	2	0.00***	3	2	0.00***
Cause hard pans	2	2	0.00***	3	2	0.00***

*** significant at 1% level

The median scores of subjective norm scale for farm-forestry adopters indicated that they agreed that immediate family members, extended family members, friends, fellow farmers, farmer groups and village chief think they should plant trees on their farm. Median scores for Farm-forestry non-adopters indicated that they disagreed that that immediate family members, extended family members, friends, fellow farmers, farmer groups think that they should grow trees on their farm. They however agreed that the village chief thinks they should grow trees on their farm. Generally farm-forestry adopters had more social pressure to plant trees than farm-forestry non-adopters. Regarding motivation to comply both farm-forestry adopters and non-adopters had the same median scores. Mann-Whitney U test was carried out to find out if there were statistically significant differences in the median scores of farm-forestry adopters and non-adopters on the normative beliefs and the results are presented in table 4.10. The results indicated that there was statistically significant difference in 5 of the 7 normative beliefs. For the motivation to comply there was no statistically significant difference in the motivation to comply with salient referent among the farm-forestry adopters and non-adopters. These results closely resemble those of Zubair & Garforth (2006) who used Mann-Whitney U test to test for statistically significant difference in the beliefs underlying subjective between farm-forestry and non-adopters.

Table 4.10: Median and Mann-Whitney U test result for subjective norm

	Normative belief			Motivation to comply		
Salient referent	FF adopter median	FF non-adopter median	M-W significance	FF adopter median	FF non-adopter median	M-W significance
Immediate family members	4	2	0.00***	3	3	0.26
Extended family members	4	2	0.00***	3	3	0.49
Farmer group	4	2	0.00***	3	3	0.08
Friends	4	2	0.00***	3	3	0.54
Fellow farmer	4	2	0.00***	3	3	0.59
Village chief	4	4	0.14	3	3	0.61

*** significant at 1% level

Perceived behaviour control consisted of factors that facilitate or hinder the performance of behaviour. This study examined 3 factors that would facilitate adoption of farm-forestry and six factors that could potentially hinder adoption of farm-forestry. The median score for farm-forestry adopters on the factors that facilitate adoption of farm-forestry was 4; that is they agreed that those factors were true in their cases. The median score on factors that hinder adoption for farm-forestry that hinder adoption of farm-forestry was 2; indicating that

adopters disagreed that those factor hindered adoption of farm-forestry. Farm-forestry non-adopters median scores show that they disagreed that tree seedlings are easily available to them but they agreed that they had enough water on their farm and also enough time to carry out all their farming activities.

On factors that hinder adoption, non-adopters median scores indicated that they agreed that farm-forestry was a long term business, they agreed that they often encountered livestock grazing on their land and that they had no knowledge of the appropriate tree varieties for their area. But they disagreed that the market for tree products is unavailable, that rainfall is irregular and inadequate and that they encounter termites on their farms. The median scores on the power of control beliefs indicated that both farm-forestry adopters and non-adopters strongly agreed that the facilitating factors would make adoption of farm-forestry easy. However for the power of control beliefs of the salient beliefs that hinder practicing of farm-forestry the median scores of farm-forestry adopters and non-adopters differed. The adopters indicated that even if the hindering factors existed they would still practice farm-forestry while the non-adopters indicated that hindering factors will make it difficult for them to practice farm-forestry.

Mann-Whitney U test was carried out to see if there were statistically significant differences in the median scores on the factors that facilitated or hindered adoption among farm-forestry adopters and non-adopters and the results are displayed in table 4.11. The results showed there was statistically significant difference on the factors that facilitated adoption. Farm-forestry adopters significantly experienced factors that facilitated tree planting more than the non-adopters. On factors that hinder adoption there was statistically significant differences in 4 of the 6 factors, farm-forestry non-adopters were significantly saw hindering factors; "farm-forestry is a long-term business", "I often encounter livestock grazing on my land" and "I have no knowledge on the tree varieties suitable for my area were significant. While "the market for tree products is unavailable" was significant. Regarding the power of control beliefs, for the enabling factors there was no statistically significant differences in the median scores of both the adopters and non-adopters of farm-forestry. On the other hand, with regards to hindering factors the Mann-Whitney U results indicate that there were statistically significant differences in the median scores of farm-forestry adopters and non-adopters. These findings closely reflect findings by Zubair & Garforth (2006) who used Mann-Whitney to test beliefs concerning the factors that hinder or facilitate the performance of farm-forestry; lack of access to seedlings and damage of trees by animals were found to be significant.

Table 4.11: Median and Mann-Whitney U test results for Perceived Behavioural control

Salient control beliefs	Control beliefs			Power of control beliefs		
	FF adopters median	FF non-adopters median	M-W significance	FF adopters median	FF non-adopters median	M-W significance
Tree seeds and seedlings are easily available to me	4	2	0.00***	5	5	0.93
Water is sufficiently available in my land	4	4	0.00***	5	5	0.90
I have enough time to carry out all my farm activities	4	4	0.00***	5	5	0.92
The market for tree products is unavailable	1	2	0.011**	3	2	0.00***
Farm-forestry is a long-term business	2	4	0.00***	3	2	0.00***
I often encounter livestock browsing on my farm	2	4	0.00***	3	2	0.00***
Rainfall is irregular and inadequate	2	2	0.156	3	2	0.00***
I often encounter termites on my land	2	2	0.138	3	2	0.00***
I have no knowledge on the tree species suitable for my farm	2	4	0.00***	3	2	0.00***

** significant at 5% level *** significant at 1% level

The attitude indices for both farm-forestry adopters and non-adopters were computed by summing the product of belief strength and outcome evaluation. Farm-forestry adopters had higher attitude indices than farm-forestry non-adopters. A t-test was then run to see if there was a difference in the mean indices of farm-forestry adopters and non-adopters. The results showed that there was a difference. Subjective norm indices were computed by summing the product of normative belief and motivation to comply, here again farm-forestry adopters had a higher mean index than non-adopters. The t-test results also indicated that the mean of the two groups were statistically significant. For the perceived behavioural control construct the indices were calculated by summing the products of control beliefs and the power of control beliefs. Once more the adopters had a higher mean index than the non-adopters, t-test results show that the mean were significant.

Table 4.12: T-test results on difference of attitude, subjective norm and PBC between adopters and non-adopters of farm-forestry

Variable	Adopters	Non-adopters	t value	p-value
Attitude Index	171.36	147.46	6.47***	0.00
Subjective Norm	90.62	62.15	7.65***	0.00
PBC	95.95	83.52	5.23***	0.00

4.6 Socio-economic and psychological factors that influence the adoption of farm-forestry

Table 4.13 below shows the socio-economic and psychological factors that influence the adoption of farm-forestry. The Pseudo R^2 also known as McFadden's pseudo R-squared was 0.15. This R^2 is not equivalent to the R^2 in simple and multiple regression models and therefore cannot be interpreted in the same way (UCLA: Statistical Consulting Group, 2019). The Tobit model fit is shown by the high negative log likelihood value of -271.20 which was found to be statistically significant ($\rho<0.01$) as shown by the Likelihood Ratio (LR) Chi-Square test. This indicates that all the predictor variables had an effect on the outcome variable. However as shown in the table some predictor variable were more important in predicting the outcome variable as shown by their individual significance levels. Land tenure was found to significantly and positively predict adoption. This findings corroborate with Mugure et al (2013) posited that the practice of farm-forestry was hinged on the right of a farmer to plant and use trees which in turn depended on the type of land tenure one had, tree tenure and land tenure are therefore interdependent. Secure land tenure is important for any long-term investment such as farm-forestry and other sustainable land use practices that are

environmentally friendly. Furthermore studies indicated that if a farmer has no security over a certain piece of land planting trees is often out of question.

Gender of the household head was also established to positively and significantly predict adoption. Indeed as the chi-square statistic revealed earlier that there was a relationship between gender and adoption of farm-forestry whereby male headed farming households were found to have significantly adopted the practice more than female headed households. This is consistent with studies that showed that the average female-headed households are less likely to practice farm-forestry as compared to the male-headed farm households (Thangata & Alavalapati, 2003; Sanchez & Jama, 2002).

Table 4.13: Tobit Estimate of factors influencing adoption of Farm-forestry

Tobit regression			Number of obs	=	110.00	
			Uncensored	=	58.00	
Limits: lower = 40			Left-censored	=	52.00	
upper = 400			Right-censored	=	0.00	
			LR chi2 (12)	=	92.62	
			Prob > chi2	=	0.00	
Log pseudolikelihood = -271.20			Pseudo R2	=	0.15	
Variable	Coefficient	Standard Error	T ratio	Level of Significance	(95% Conf. Interval)	
Age-group	1.22	1.88	0.65	0.52	-2.52	4.95
Gender	16.60	8.71	1.91	0.01**	-0.68	33.87
Education Level	1.75	0.97	1.80	0.07	-6.37	5.81
Extension	8.68	7.03	1.23	0.22	-5.27	22.63
Off-farm income	-8.27	8.92	-0.93	0.36	-25.97	9.42
Group membership	8.83	6.55	1.35	0.18	-4.17	21.82
Land tenure status	33.18	13.01	2.55	0.00***	7.37	58.98
Agricultural enterprise	6.22	9.28	0.67	0.50	-12.19	24.62
Land size	0.15	0.42	0.36	0.72	-0.59	0.74
Attitude	0.30	0.16	1.87	0.06	-0.01	0.63
Subjective norm	0.29	0.17	1.70	0.09	-0.04	0.63
PBC	0.23	0.22	1.03	0.30	-0.21	0.68
Constant	-275.473	51.04	-5.4	0.00***	-376.76	-174.19

** Significant at 5% level *** significant at 1% level

4.7 Thematic analysis of farm-forestry adopters and non-adopters

Farm-forestry adopters and non-adopters were interviewed using an interview guide. The participants selected were twenty in number comprising of ten farm-forestry adopters and ten farm-forestry non-adopters. The twenty were selected from a sampling frame from the larger quantitative data collection that was conducted prior to this qualitative one. The criteria used was selection based on tree density level in which adopters with high numbers of trees per hectare were eligible for selection while non-adopter with very low tree density and those who had not planted any trees on the farms were selected. The wards of Narok North Sub-County are five in total therefore the participants' selection was also done with this mind resulting in the selection of two farm-forestry adopters and two non-adopters per ward. The interview questions were three and were more or less similar with a slight variation depending on whether the person interviewed was an adopter or a non-adopter. The responses were then analysed using thematic content analysis and presented in form of thematic networks.

Thematic networks are web-like drawings that give a summary of the main themes generated from qualitative data (Attride-Stirling, 2001). Thematic networks technique is a tool for both analysis of qualitative data and presentation of the results. This data analysis and presentation techniques provides a step by step practical and effective procedures for carrying out qualitative data analysis and organizing the analysis (Attride-Stirling, 2001). Furthermore it allowed for disclosure of the steps used for analysis and gave a clear picture on how the main themes were generated. The analysis for this data first involved transcription of the recorded interviews by typing them into Microsoft word documents. Secondly the transcribed materials were read and the themes were generated using the thematic network method. The first step of the analysis involved generating and coding basic themes. These basic themes were mostly texts from the transcribed responses used directly by the participant when answering a particular question. The second step entailed combining related basic themes and coding them to form organizing themes. And the final step involved reading and deciphering related organization themes before coding them to obtain global themes. The themes that were adopted and presented were those that had a high degree of consensus from the people interviewed.

The first objective of the qualitative part of this study was to find out the views of both farm-forestry adopters and non-adopters on farm-forestry practice. The first question on the interview guides for both the farm-forestry adopters and non-adopters represented this

objective. This question was of importance to the research as understanding the views held farm-forestry adopters and non-adopters had regarding farm-forestry could give insights as to why some farmers would choose to practice farm-forestry while others choose not. Basic, organizing and global themes were generated from the responses given by the ten farm-forestry adopters selected from across the wards of the Sub-County. Adopters generally noted that farm-forestry was important and beneficial, their responses centred on the benefits of farm-forestry. Two thematic networks were generated from the responses, the first one was that farm-forestry improves environmental and human well-being and the second network was that farm-forestry is a beneficial investment. In concluding that farm-forestry improves environmental well-being, adopters cited trees ability to temper harsh climate, create micro climates and improve soils. All the adopters interviewed were aware of these beneficial aspects of farm-forestry and mentioned them extensively. It was also clear that adopters recognized and appreciated the intangible benefits of farm-forestry. When articulating their thoughts on farm-forestry adopters also mentioned the peace, serenity and beauty brought about by having trees in their environments. Below are some excerpts from the responses on adopters' opinions on farm-forestry.

> *"Trees are very important and we should all endeavour to plant trees in our farms. I have mostly enjoyed the calmness trees create, the fresh air and serenity that comes with having trees. The fruits also and the tree residuals which I used for mulching my crops to bring rain and for aesthetic purposes and so far I have enjoyed the shade and clean air created by the trees".* An Adopter farmer from Nkareta Ward

> *"I think farm-forestry is very beneficial for us as farmers and the environment at large, trees act as wind breaks, provide shade and bring fresh air also for firewood and fodder for my goats, especially indigenous trees like acacia are very much loved by goats. Some indigenous trees are also medicinal and I therefore preserve them for that purpose. For because I have planted lots of trees on my land I have enjoyed the fresh air and shade, firewood and fodder from the indigenous trees on my land. I love the peace and serenity that trees have brought to my compound, the fresh air and the beautiful birds that flock here just because of these trees".* An adopter from Melili Ward.

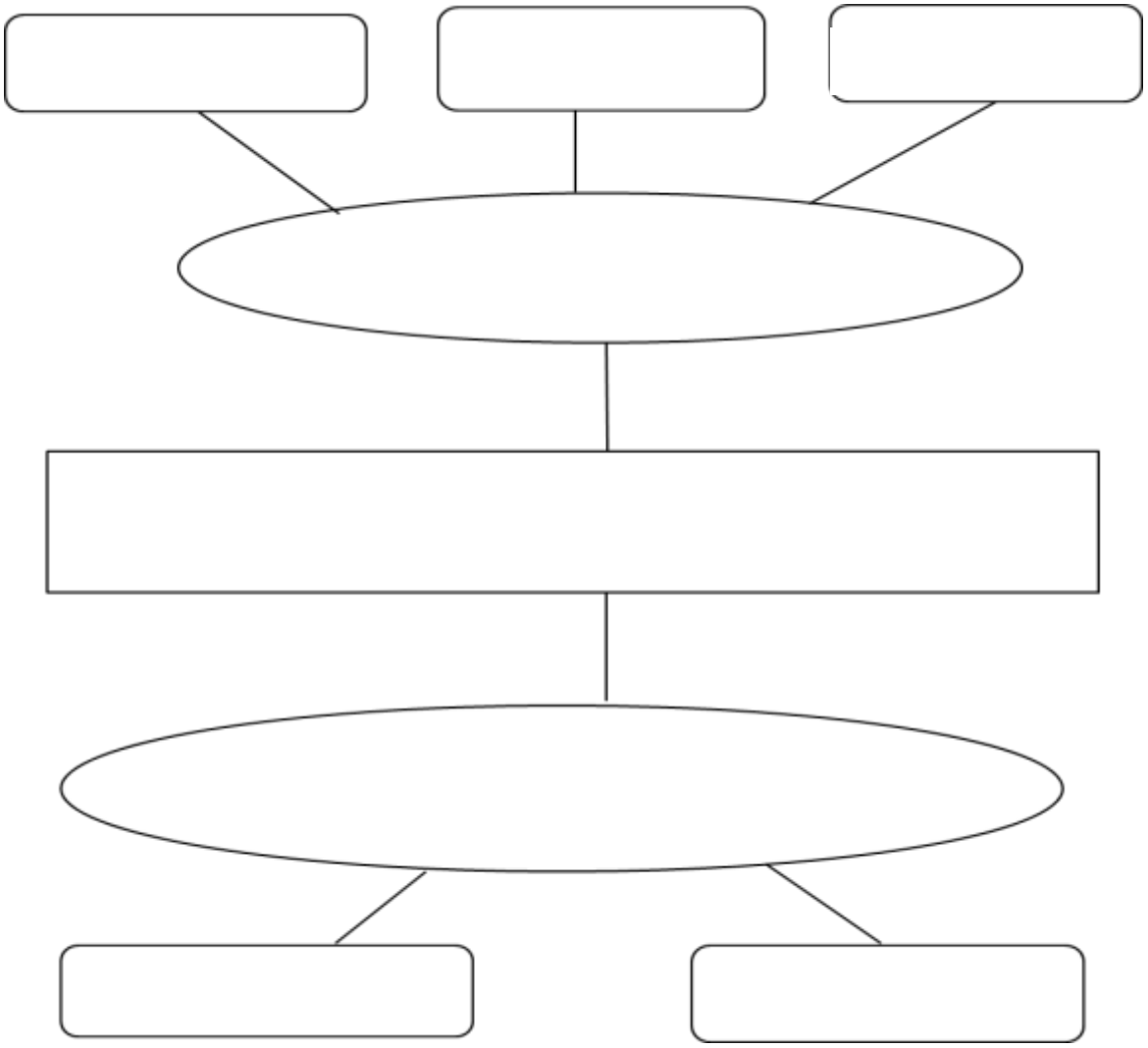

Figure 5: The thematic network for farm-forestry improves environmental and human well-being

The second thematic network generated from their response to their opinion on farm-forestry was that farm-forestry is a beneficial investment. Here they mentioned that trees provide them their household needs such as fuel needs, nutritional needs, medicinal and cultural needs. A farmer would have otherwise incurred costs to meet these needs but instead got them 'freely' from trees.

Farm-forestry adopters also mentioned that trees have economic benefits; here they viewed trees and tree products as a source of income. Adopters perceived trees as having economic value just like cultivated crops. Adopters with this view are seen to be entrepreneurial in nature in that they viewed trees as an investment that could yield returns in the future. They

not only saw tree products and mature trees as a source of revenue but also the trees seedlings.

Adopters also indicate that trees had indirect economic benefits from their ability to protect and enhance soils which increased their agricultural productivity. In viewing trees as aiding and increasing agricultural production, farmers can be motivated to incorporate them in their farms as is the case of the adopters. In addition with this view in mind farmers can also use tree planting as a measure of restoring degraded land and or land that has lost its fertility. The recognition of the importance of trees in this aspect could be one of the motivations to adopt farm-forestry as they see trees as enabling agricultural production as opposed to competing with crops. This belief that trees reinforce agricultural production is powerful and could enable more farmers to adopt farm-forestry. Below are some excerpts from the adopters' responses.

> *"Trees are also important because they are used as timber for commercial purposes and construction, firewood, act as a live fence and windbreakers. So far they have benefited me directly as I have enjoyed income from sales of timber trees, firewood….i also love my trees because* they *prevented soil erosion on my farm by acting as windbreakers and unlike other farmers in this village my farm is not experiencing soil erosion".* An Adopter from Olposimoru Ward

> *"Planting trees on farm-land is very important as it has numerous benefits for me I started planting trees for reasons such as for commercial timber, to meet my household needs, to bring rain and for aesthetic purposes and so far I have enjoyed the shade, fruits, firewood and clean air created by the trees.* Adopter from Melili Ward

> *"Trees are very important I have planted them on my farm so as to obtain building timber and commercial purposes, firewood, to act as a live fence, windbreakers and shade. Trees also provide fresh air and make the environment serene. So far I have harvested and sold timber, I have my own firewood and I enjoy the fresh air and serene environment provided by my trees".* An Adopter from Olposimoru Ward

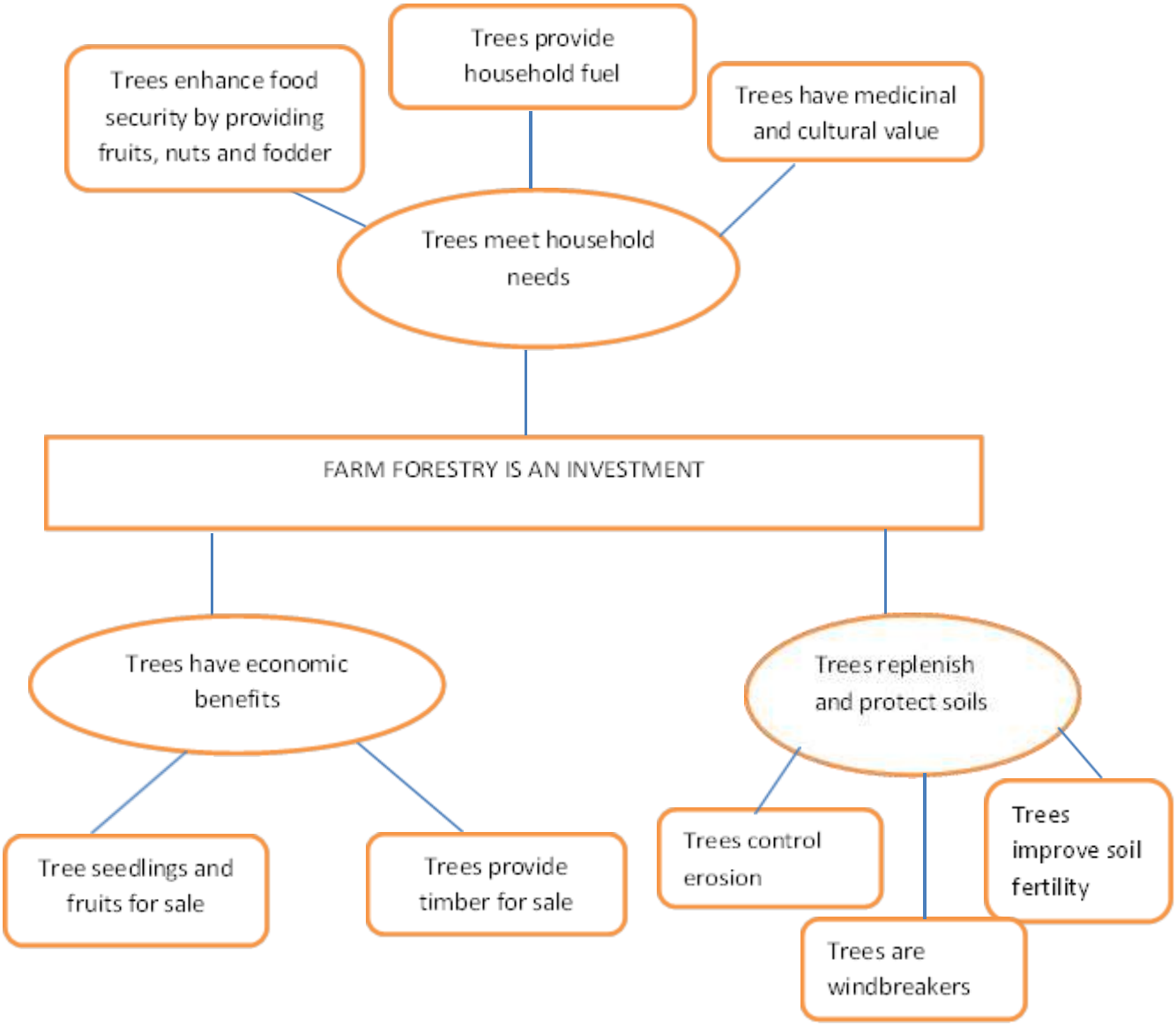

Figure 6: Thematic network Farm-forestry is an Investment

Non-adopters were asked also asked about their on their views on farm-forestry, two thematic networks were generated from their responses. The first one is that farm-forestry is a beneficial venture here they identified both economic and environmental benefits of farm-forestry which formed the organizing themes for this network. Just like the adopters, the non-adopters recognized the tangible economic benefits of trees such as its potential to become a source of income through the sale of its products, fruit and nut trees provide nutrition needs for the household and to provide fuel-wood for the household. Non-adopters also mentioned the environmental benefits of trees, they recognized that trees prevented soil erosion and created micro-climates through shades that moderate harsh temperatures. This showed that non-adopters had full awareness of the overall importance of trees despite them not adopting them. See some excerpts below representing the non-adopters' responses.

"Farm-forestry has a lot of benefits, this is because it can attract rain, provide fresh air and it can be a source of income when you sell timber and fruits. Yes it can also provide you with fuel wood which is becoming expensive these days"…. Non- adopter from Olokurto Ward

"It is important to plant trees on the farm since they can serve as windbreakers, provide timber and firewood provide and income and even give you shade and make a place beautiful….." Non Adopter from Nkareta Ward

"It is something important since it is a source of furniture, firewood and an income source. Trees also prevent soil from being carried away by water or wind and we are told it attracts rain though am not sure how it does that. Yes, trees are very good but ....". Non-Adopter from Melili Ward

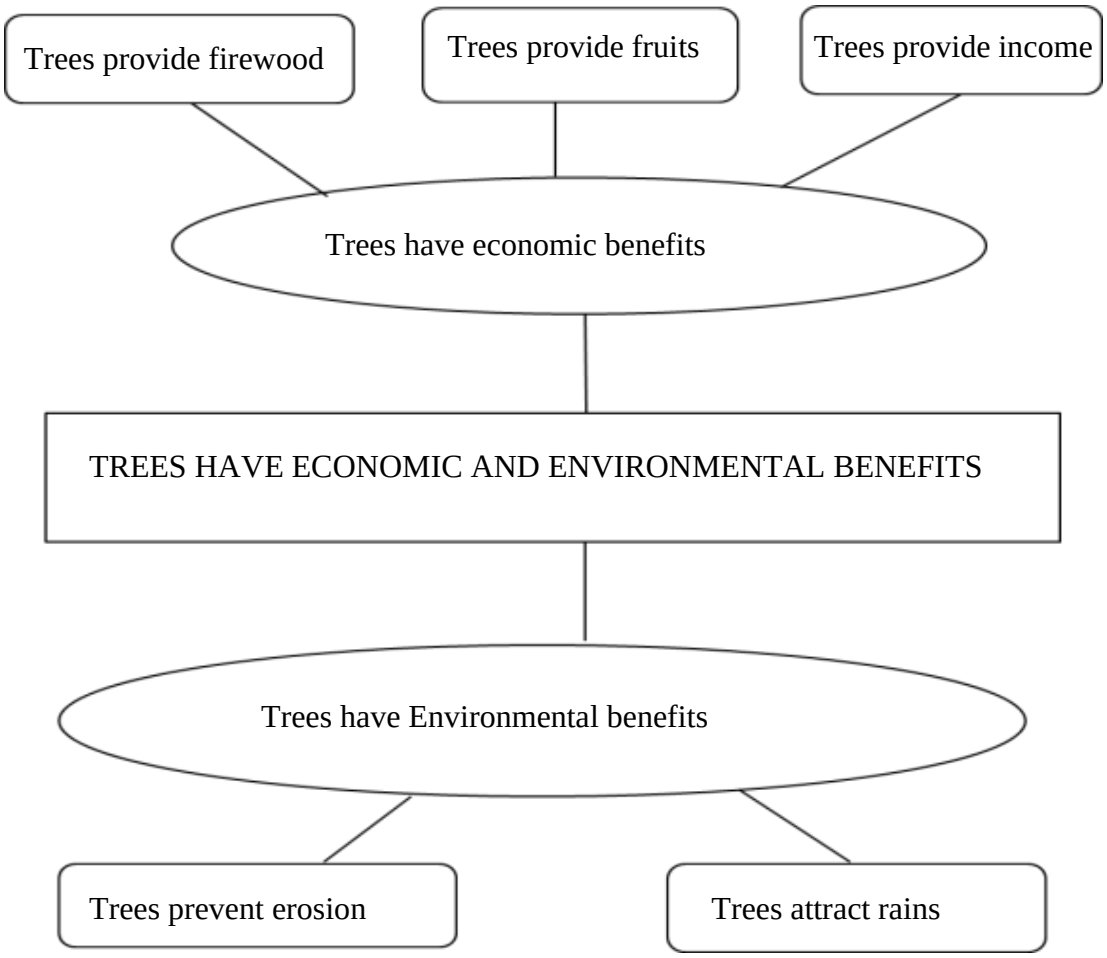

Figure 7: Thematic network for farm-forestry is a beneficial venture

However even after recognizing that tree growing is beneficial venture; non-adopters also had some reservations about the practice. Farm-forestry non adopters also felt that practicing farm-forestry was risky and that the benefits are not immediate. Some of the non-adopters felt that even though trees are good, most trees took long to grow and mature. Those who had these sentiments felt that it took too long for them to reap the benefits of trees as compared to crops whose benefits are realized within a cropping season. Indeed it is a fact that farm-forestry is long-term venture with distant fruition and this aspect could discourage small scale farmers who may be living a subsistence livelihood where immediate benefits will be preferred. Those who had these sentiments felt that it took too long for them to reap the benefits of trees as compared to crops whose benefits are realized within a cropping season. They cited that drought and water scarcity would make it difficult to grow trees. They had concerns that trees may compete with crops for water and space and while others believed that trees generally do not do well in their area.

These views separated the adopters from the non-adopters in that even though both categories were aware that trees are important, non-adopters felt that it was a long-term commitment and were uncertain about its success in their context.

….. *"Yes, trees are very good but this area is dry it will be hard to grow them here because of water unavailability".* Non-adopter from Melili Ward

……*"but it takes a long time to realize benefits of trees and my land is small and I have to grow food for my family".* Non-adopter from Olokurto Ward

'The only problem is that the benefits are not immediate as compared to crops and I live from hand to mouth so I rather plant something that I can sell and earn an income within a short period of time. Trees are good when so when am more financially stable I intend on planting them". Non-adopter from Nkareta Ward

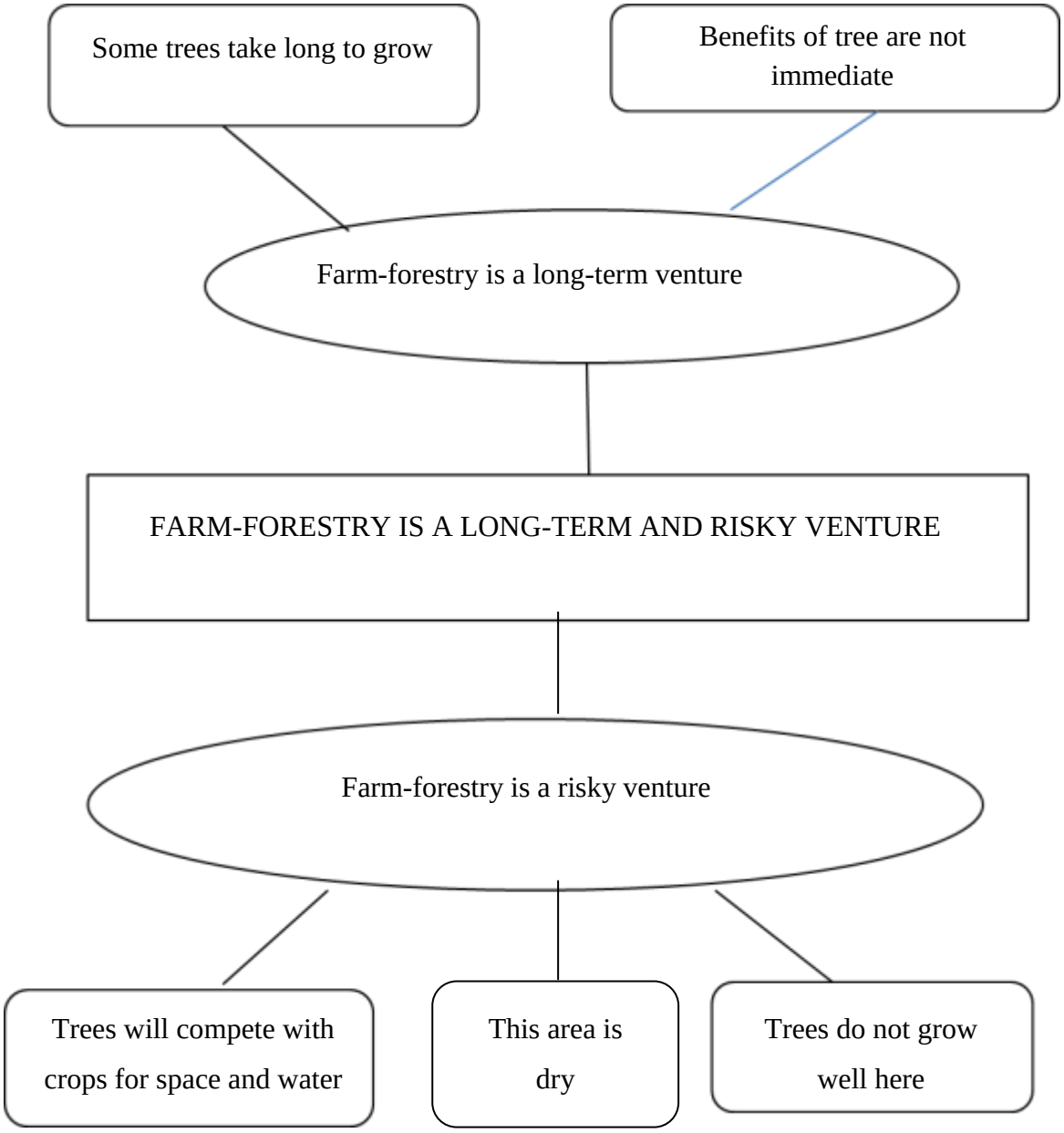

Figure 8: Thematic network farm-forestry is a risky long-term venture

The findings of this first objective of the qualitative study corroborate with the quantitative data results for attitude aspect in the psychological factors that influence adoption of farm-forestry where it was noted that both farm-forestry adopters and non-adopters acknowledge the positive aspects of farm-forestry. The results also explain why non-adopters in the quantitative analysis identified the potential negative effects of farm-forestry more than the adopters.

This study has found that both the adopters and non-adopters recognized and talked about the tangible economic and environmental benefits of trees. Adopters in particular mentioned economic benefits as a major incentive in their adoption decision. Indeed, such farmers have been shown in studies that farmers with a more entrepreneurial orientation tended to plant more trees than others as they perceived the practice as investment that would eventually earn higher returns in the future (Jerneck & Olsson 2013). However, only the adopters mentioned the intangible benefits of farm-forestry such cultural value and serenity created by the trees. Indeed solid scientific evidence ascertains the tangible environmental and economic benefits that farmers and societies at large can enjoy by practicing farm-forestry (Jose, 2009). Moreover, studies show that small-scale farmers are indeed aware of the tangible benefits of trees which they and future generation can reap from. However, most peasant farmers are said to recognized mainly tangible and immediate benefits of trees as opposed to the intangible long-term benefits (Jerneck & Olsson 2013).

None of the adopters and non-adopters mentioned the carbon storing and biodiversity advantages of farm-forestry when citing their opinions. This could be an indication that they view the benefits of farm-forestry as more of personal benefits as opposed to societal benefits. Jerneck & Olsson (2013) argued that these benefits may not be obvious or well known to peasant farmers whose priority is agricultural production and food security. They further postulated that carbon sink and biodiversity benefits are often lauded by international development agencies but are not necessary the priorities of peasant farmers.

The findings of this study also show that although non-adopters realized the benefits of farm-forestry they also saw it as long-term and risky investment. These explain PBC aspect that was analysed in the quantitative study. Small-scale farmers have been shown to experience production risks related to drought, climate variability, pests and diseases (Morton, 2007). Therefore any investment that is deemed to be risk and might compromise their food production in the short-run is likely to be rejected by such farmers. Additionally the non-adopters who maybe cash-constrained could be gauging the opportunity cost of establishing trees that yield long-term benefits versus crops whose benefits are more immediate (Kiptot & Franzel, 2011). Jerneck & Olsson (2013) posited that the there is an inherent difference between the viewpoints of the experts and farmers with regards to the practice of farm-forestry. In that while expert will be puzzled by the reluctance of farmers to adopt farm-forestry despite the numerous benefits it provides, the farmer may be factoring the efforts, resources and risks related to the adoption and question if it is rational to adopt it.

4.7.1 Challenges and Hindrances in the Adoption of Farm-forestry Practices

Farm-forestry adopters were then asked about the challenges they have been facing with regards to tree growing ever since they adopted the practice. After their responses were analysed they generated two thematic networks one was input constraint and the second one was on tree survival rates. Input constraint was the term adopted to summarize challenges of obtaining, affording and utilizing inputs needed in farm-forestry practice. Water is one of the inputs that is crucial for tree growing and the adopters mentioned that frequent droughts and water unavailability challenged their practice of farm-forestry. Since trees require watering in order to survive past the seedling stage, after that need adequate rainfall so as to be of high quality water constraints, therefore, are a major challenge. Furthermore most households in the study area practiced rain-fed agriculture hence recurring droughts would make crop production and tree planting difficult. In order to overcome this constrain farmers will have to incur costs and time investing in water harvesting techniques and innovations. However this will make farm-forestry more capital and labour intensive which is a disincentive to resource-poor farmers.

Moreover, majority of the adopters also mentioned unavailability and unaffordability of quality seedlings as a challenge. Adopters cited that the tree nurseries near them did not have different varieties of seedlings and that seedlings available were not of high quality. They revealed that they had to incur transport costs in order to acquire high quality seedlings which were highly priced. Adopters also revealed that they did not have adequate knowledge on the appropriate species for their climatic zone and that they mostly planted the type of trees that they saw others in their area planting. Farm-forestry is a knowledge intensive practice therefore inadequate knowledge and skills will reduce adoption rates and reduce returns from tree planting. In order to overcome these challenges adopters have to incur transactional costs to acquire information and quality seedlings.

> *"Insufficient water has made it hard to plant more trees…I usually I dig up big holes and fill them with manure and organic matter then plant my trees, the size of the holes and manure help preserve water and help the trees grow in dry areas like here".* An adopter from Melili Ward

> *"The main challenge is watering the trees since rains here are inadequate and unreliable there is need to irrigate the trees which is labour and capital intensive……."*An adopter from Nkareta Ward

"Another challenge is getting knowledge on ideal species I have mostly learned through trial and error which is not the right way". Adopter from Oloropil Ward

"….i have also found it challenging accessing high quality seedlings, the tree nurseries I know don't offer much variety and I even doubt if they are certified so I usually get my seedlings from Nakuru which is a bit costly for me". Adopter from Olokurto Ward

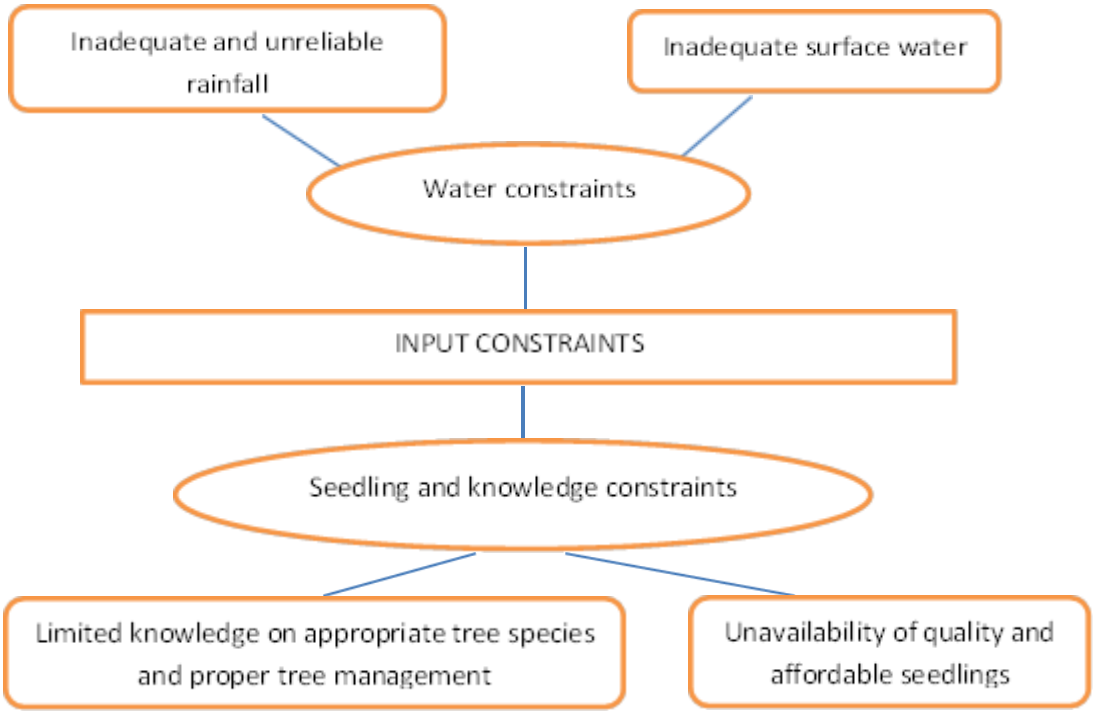

Figure 9: The thematic network input constraints

The adopters also mentioned a set of challenges revolving around tree survival rates. This included destruction of trees by livestock and wild animals and trees being attack by pests and diseases. Their main concerns were that after planting trees not all of them reach maturity and therefore a part of their investment was lost.

Most of the household in the study area practiced agro-pastoralism and small livestock browsing on seedlings and young trees was cited by the adopters as a major challenge. Therefore, they had to put more efforts in protecting and guarding their tree seedlings. Freely grazing livestock such as goats can hinder natural regeneration of indigenous trees as they browse on young trees and seedlings. Some adopters also experienced destruction of indigenous trees by wild animals; acacia in particular were reported to be destroyed by elephants.

Adopters also mentioned that in their practice of farm-forestry some trees were attacked by diseases and due to lack of knowledge on tree diseases and ways to control and prevent the diseases, trees would in extreme cases die. They also cited that trees were often attacked by pests and insects but getting information on how to control tree pests was hard. These challenges have negative impacts on tree survival and adopters are not able to optimize on the benefits of farm-forestry. In order to overcome this challenge adopters have to incur transactional costs in searching for information on how to control tree diseases and pests.

> *"Goats like browsing on young trees and have destroyed some of my seedlings and young trees, wild animals like elephants sometimes destroy the trees I have conserved such as the acacia trees*". Adopter Melili Ward

> *"tree diseases have also been a challenge for me some years back my trees were affected by some diseases and it was frustrating to get information on the how to treat them since agrovets and extension officers mostly deal with crops and didn't know much about tree diseases".* Adopter from Olposimoru Ward

> *"Another challenge is that my cypress trees were attacked by pests and I have very little knowledge on tree pests and it is hard to get agrochemicals specifically for trees in agrovets. Also extension officers at the county know little about trees diseases and treatment and cannot offer much advice"* Adopter from Olokurto Ward

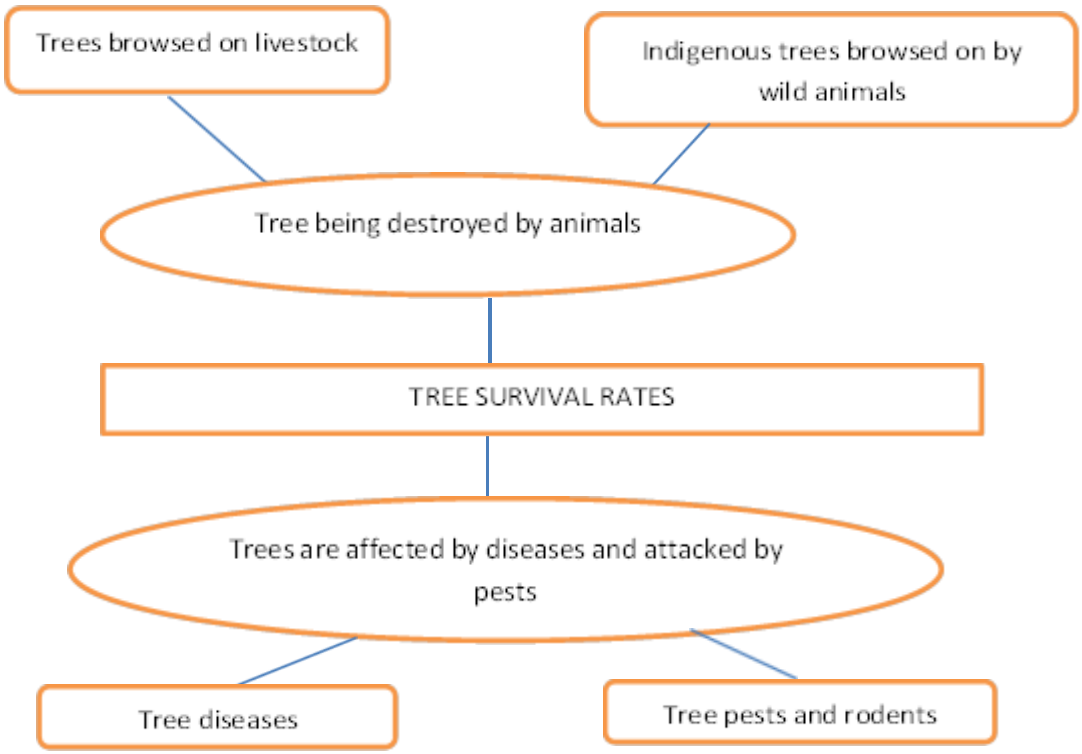

Figure 10: Thematic network tree survival rates

Farm-forestry non-adopters were likewise asked about the challenges that hindered them from adopting farm-forestry. Their responses generated two thematic networks that summarized their challenges, one being climatic barriers and the other resource barriers.

Climatic barriers entailed weather related barriers that caused water scarcity and seasonal food insecurity. Unlike adopters non adopters have not been able to overcome these challenges. Here, non-adopters cited that their regions were dry and experienced frequent drought and water scarcity which made it hard for them to plant trees. Non-adopters noted that trees require and consume water when being planted as they grow and this resource was already scarce on their farms. Therefore, they perceived growing trees in such condition as risky. To overcome these challenge non-adopters will need to invest more in water harvesting. This could potential be the reason why they abstain from farm-forestry as it becomes more capital intensive and risky for them.

With regards to the retention of naturally regenerating trees which forms part of farm-forestry, non-adopters indicated that frequent droughts have made it difficult for them to retain indigenous trees on their farms. This was because the droughts led to crop failure and

in efforts to avert food insecurity they turned to charcoal burning as a source of income. Susceptibility to food insecurity thus, constrains farmers' ability to practice farm-forestry.

> *"Another thing is that this area is dry with inadequate and unreliable rainfall it will be difficult to grow trees here and even if they grow the dry environment also make trees take long to mature. if there was enough water I would plant because trees are very important".* Non-adopter from Melili Ward

> *I have not yet planted trees because it is very dry here but will after I invest in a borehole because trees are very important. Yes they are important and I think that we are experiencing frequent droughts simply because we do not have a lot of trees here, look around, most of our farms are bare and have very few trees and this is serious because trees attract rain* .Non-adopter from Nkareta Ward

> *The natural trees are here but because of poverty we burned them for charcoal in order to get by because of the frequent crop failure. Unfortunately burning charcoal will increase the drought but we have to survive, we have no option but to burn charcoal to buy food and educate our children.* Non-adopter from Nkareta ward

> *"…many residents opt to burn indigenous trees in order to get cash since crops have been failing due to frequent droughts and this makes the dry situation worse".* Non-adopter from Melili Ward

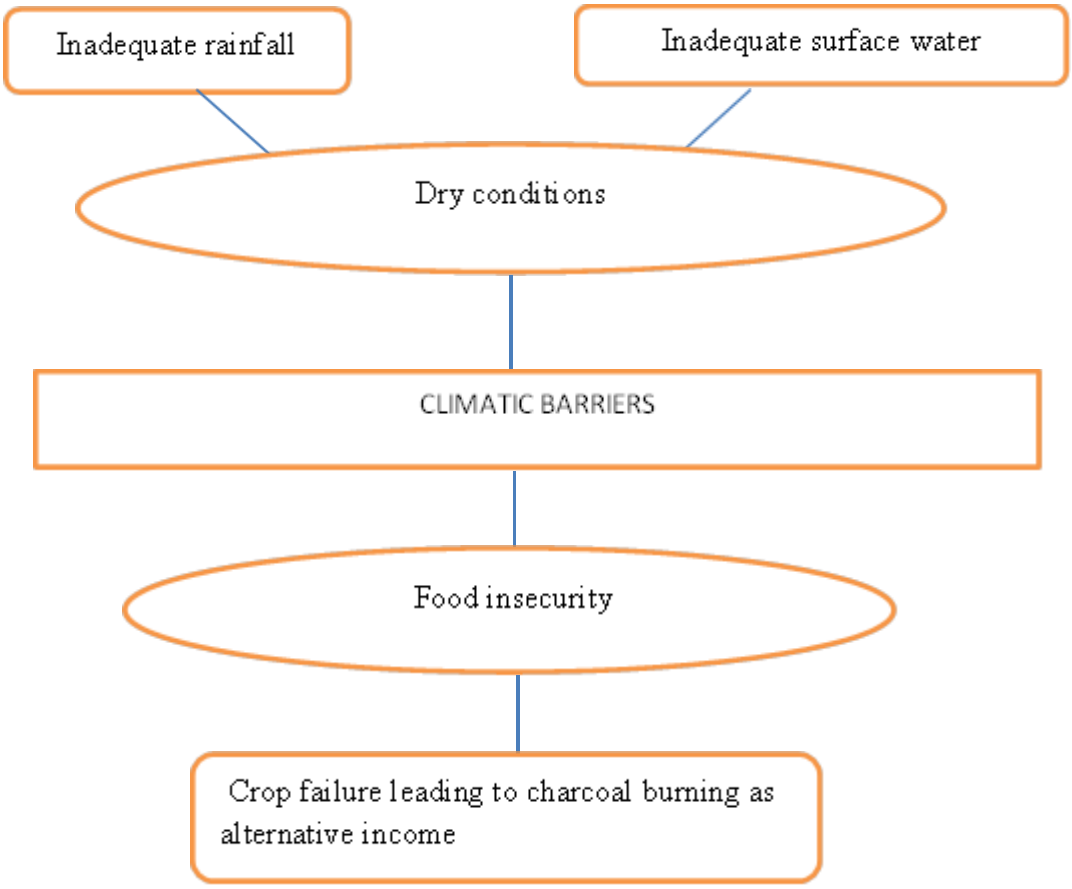

Figure 11: The thematic network climatic barriers

Non-adopters also cited barriers revolving around limited resources as one of the challenges that hindered them from adopting farm-forestry. These resource barriers included land related barriers. Some of the non-adopters interviewed mentioned that the land they owned and farmed on was too small to be able to produce food and grow trees. Consequently, these non-adopters rationally prioritize food production over practicing farm-forestry. Land size was also important for the retention of indigenous trees as farmers with small land size tend to cut down indigenous trees to expand land for cropping. Others revealed that they didn't have secure land tenure and hence could not plant trees.

'The main challenge is that our land is still under our father so without me knowing which part is mine i cannot plant trees. Trees are good and I intend on planting once am given my portion". Non-adopter from Melili Ward

"...am yet to get a bigger portion of land as our land is not subdivided so currently am using the portion I have for growing food for my family but I plan on growing trees once I get a bigger portion that is mine". Non-adopter from Olposimoru Ward

Another resource related barrier as mentioned by the non-adopters was financial in nature. In this case the non-adopters interviewed felt that tree seedlings were not affordable. Non-adopters further mentioned that due to financial constraints, they preferred short term farming investments that yielded immediate benefits as opposed to farm-forestry which took a longer time to benefit them. Indeed cash constrained farmers who have to meet daily household needs may not be in a position to invest in long-term investments such as farm-forestry which yield future returns. Another aspect of financial barrier was that non-adopters with relatively more land rented out large portions of their land to earn an income. The tenants planted high value crops in large scale which meant that the landowner could not access their land to plant trees.

> *"Everything I do on the farm needs money, buying seeds needs money, fertilizer prices are high and you can get anything here without fertilizer therefore right now I can't afford to buy tree seedlings".* Non-adopter from Olokurto Ward

> *"Also I have been renting out a large portion of my land for the last ten years to get money to support my family therefore I can't plant trees now because the land is under wheat planted by the person I have rented it to".* A Non-adopter from Olorropil Ward

Knowledge barriers were also mentioned by the non-adopters. Here non-adopters revealed that they did not know the species of trees that would do well in their regions. They further explained that they had not received any trainings on tree growing and management and therefore did not have the skills needed to practice farm-forestry. Farm-forestry is knowledge intensive practice and lack of knowledge and necessary skills is a major disincentive to practicing it.

> *"…Also I do really know about tree species suitable for this area and about early maturing tree species".* Non-adopter from Oloropil Ward

> *"The truth is I have no idea which trees do well in this area, I have heard that some trees dry up your land and I am careful because this is a dry area".* Non-adopter from Nkareta Ward

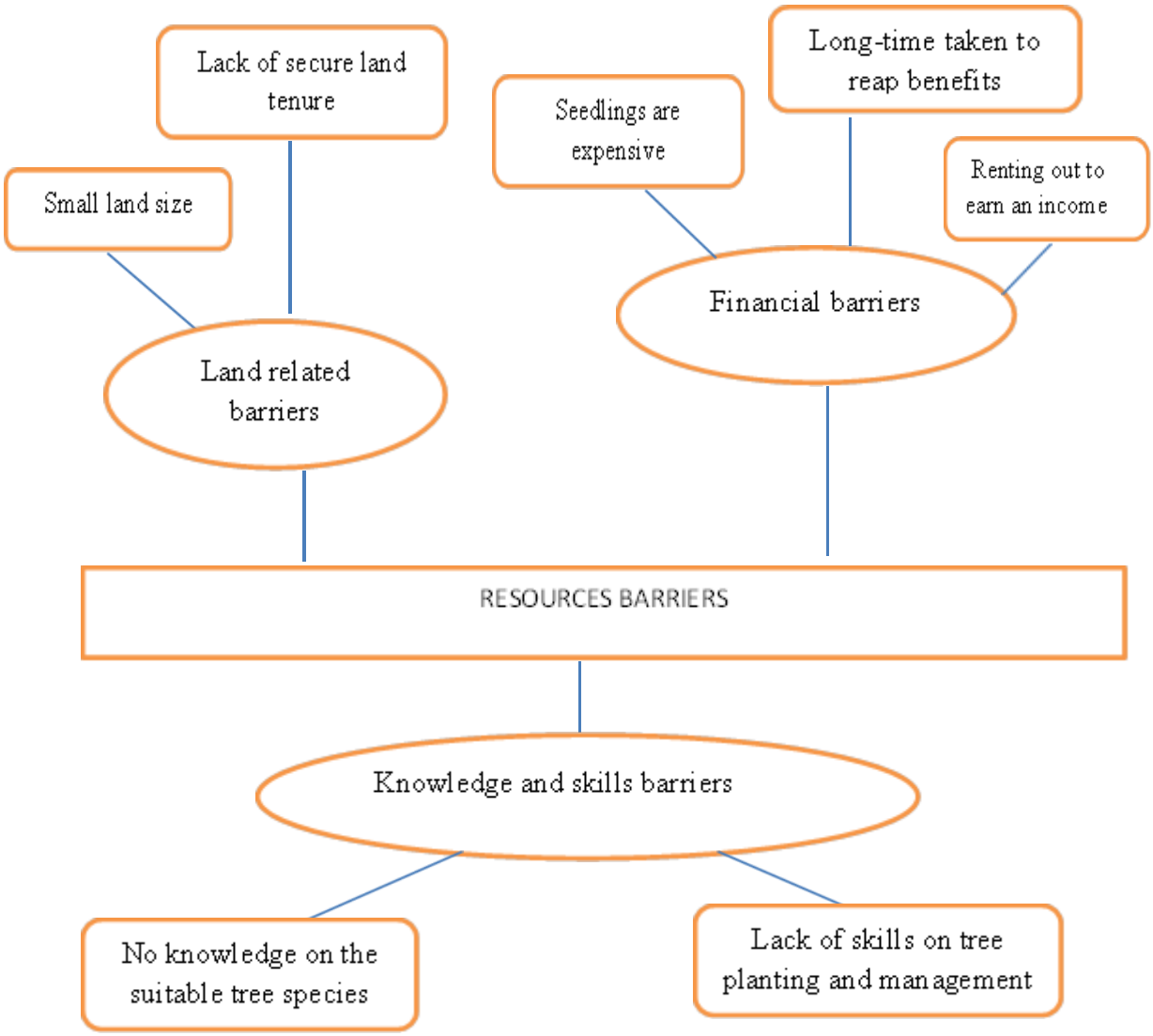

Figure 12: The thematic network Resources barriers

These results for the challenges faced by farm-forestry adopters and non-adopters explain the quantitative results for the perceived behavioural control aspect of the psychological factors that influence the adoption of farm-forestry. This psychological aspect identified that various factors outside a farmer's control could potential hinder their adoption of farm-forestry and this qualitative results corroborates this notion and explains it from farmers' own perspective.

Farm-forestry adopters mentioned input constraints as challenge that they had to overcome in order to practice farm-forestry. These inputs included water, seedlings and technical knowledge that are critical in the practice of farm-forestry. Non-adopters also mentioned these same resource constraints as barriers that hindered them from adopting farm-forestry. A majority of farm-forestry studies often look into the influence of socio-economic factors on adoption and few have considered the bio-physical conditions outside a farmer's control that

may make adoption difficult (Mercer, 2004). Despite its multiple benefits, farm-forestry is a complex, knowledge intensive and risky venture whose benefits are not immediate (Jerneck & Olsson, 2013). Farmers, therefore, have to overcome these constraints in order to successfully adopt farm-forestry.

Apart from the dry conditions farm-forestry non-adopters also mentioned food insecurity as a hindrance to their adoption of farm-forestry. They cited that due to chronic crop failures they often have burn charcoal in order to earn money that is the used to purchase food and this negates their efforts to preserve naturally regenerating trees and deters adoption of farm-forestry. Indeed, food security among peasant farmers always takes precedent over other activities such as farm-forestry (Jerneck & Olsson, 2013). Thus adoption of farm-forestry is hampered by not only the bio-physical conditions of their regions but also food insecurity.

Farm-forestry adopters also faced challenges with regards to tree survival rates, here the main concern being a loss of part of their investment in farm-forestry. This challenge is a serious one as it limits the overall benefits farmers obtain from investing in farm-forestry. Additionally these challenges may discourage new adopters from practicing farm-forestry. Non-adopters on the other hand faced financial and land barriers as a challenge that also differed from the one mentioned by the adopters. The financial barriers included the high costs of seedlings and the alternative use of land to earn an income. The land barriers on the other hand were land tenure security and land size. For resource constrained farmers often the assets needed for farm-forestry adoption competed with food production (Jerneck & Olsson, 2013). In this case, non-adopters faced both cash and land constraints and they therefore prioritized food production over farm-forestry adoption.

4.7.2 Knowledge and skills on Farm-Forestry

The third objective of the qualitative section was to find out the type of knowledge and skills on farm-forestry that adopters and non-adopters possessed. The responses from farm-forestry adopters revealed that they had skills for both establishing and managing trees. This is because a thematic analysis of their responses established that they had both basic and advanced knowledge on growing trees as shown by the two thematic networks generated. The first thematic network shows that farm-forestry adopters had basic knowledge on tree establishment. They knew different methods of planting trees, the tree species that do well in their areas and the spacing needed for different trees. These practical skills are essential for

the establishment of trees on farm-lands and make it possible for one to successfully adopt farm-forestry practices.

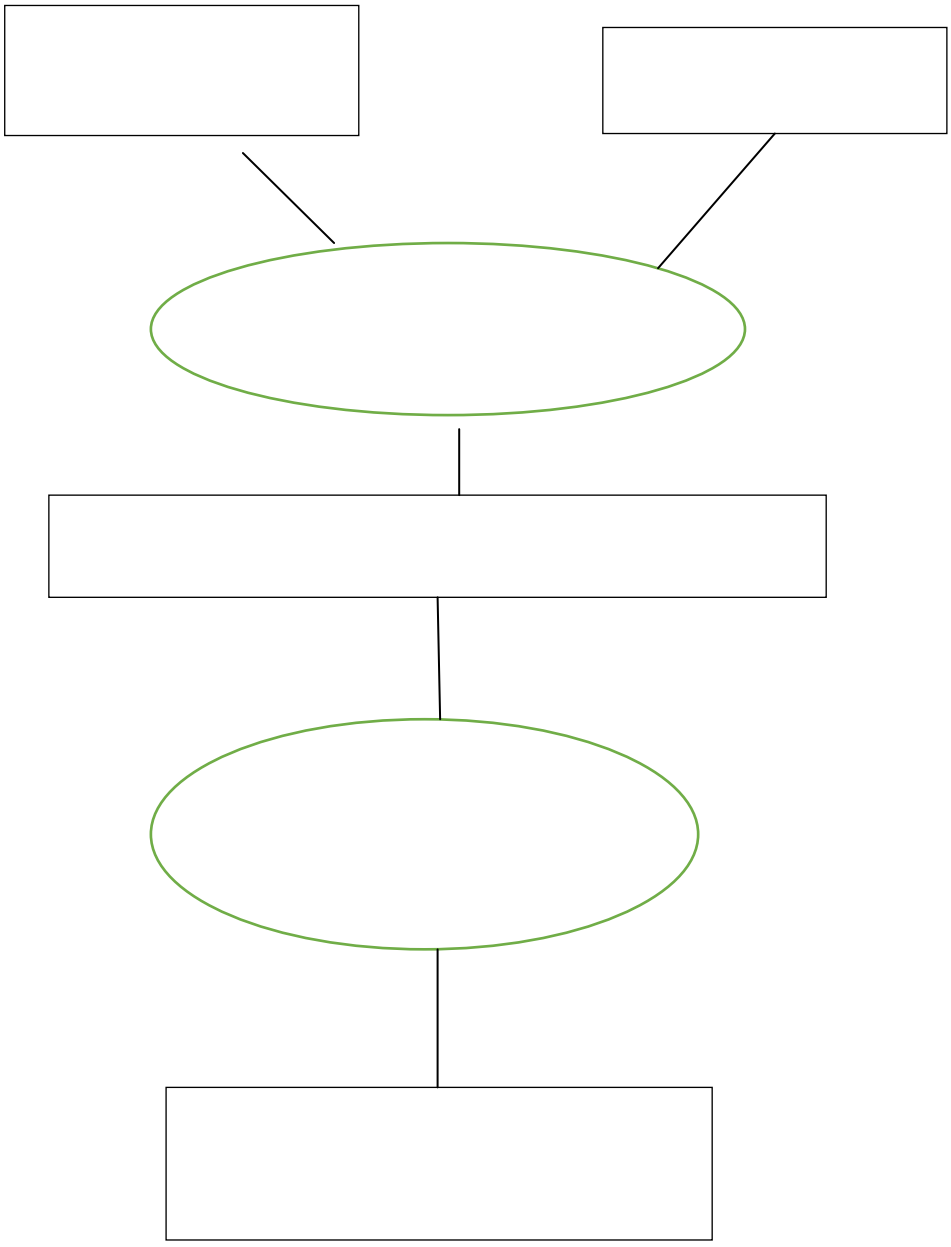

Figure 13: Thematic network basic tree growing knowledge

Additionally as the second thematic network revealed, farm-forestry adopters also had advanced skills and knowledge that were essential in proper tree management and even commercialization of timber products. They knew how to prune and erect protective barriers for young trees as well as how to make their own tree seedlings and value mature trees when selling them.

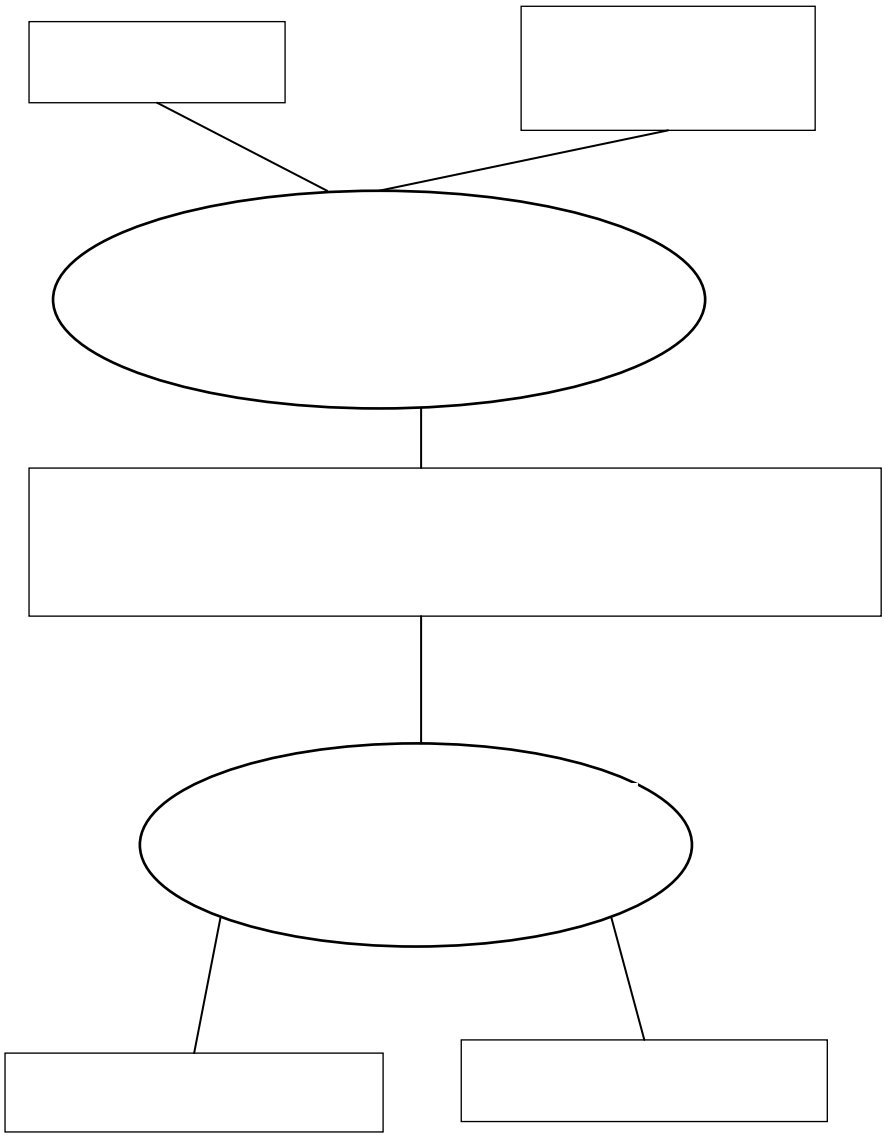

Figure 14**:** The thematic network advanced knowledge skills

I know the benefits of planting trees and I have information and knowledge on different spacing for different trees and pruning the trees so that they grow upright. Adopter from Olokurto ward

For me the biggest skill I have acquired over the years is how to trees in drier areas like here. I dig up big holes and fill them with manure and organic matter then plant my trees, the size of the holes and manure help preserve water and help the trees grow in dry areas like here. This has helped greatly in ensuring the trees I plant survive and mature. Adopter Melili Ward

The main skill I apply is in planting, the depth of the planting hole is important; it has to be deeper and bigger so that you can plant the tree and apply manure so as to

nourish the tree and preserve water. Another skill is on how to protect young trees from being browsed on by livestock. I also carry out pruning of the trees so that they grow as desired. Adopter from Nkareta ward

I know how to make seedlings and this helped reduce the cost of acquiring raw materials and has been a source of income as I also sell seedlings to other farmers. I also know the spacing for different trees and how to plant them so that they survive and not die and also pruning and managing trees until maturity. I am currently selling some of the mature trees as timber and I have learned how to value them as I have attended different trainings by farm-forestry associations. Adopter Oloropil ward

In contrast this study established that farm-forestry non-adopters possessed limited knowledge on tree establishment and management. From the non-adopters' responses and the thematic content analysis it was established that they had only the most basic knowledge on farm-forestry which mostly revolved around how to plant trees and the suitable trees to grow. Some non-adopters cited that they had basic tree growing skills and even mentioning that some trees may not be suitable as they dry up the land. However a majority mentioned that they lacked the essential knowledge and skills that would facilitate adoption of the practice. Farm-forestry is a knowledge intensive practice that requires farmers to have developed skills in establishing and managing trees on farm-lands thus inadequate skills and knowledge can serve as barrier to adoption.

I don't have a lot of knowledge and skills required to practice farm-forestry, yes I know trees are beneficial and it is important to plant them. I also know that it is not good to plant blue gums in a dry place like this and at least I know how to plant trees. Non-adopter A Melili

I know that trees are important and can be a good source of income but the skills I have are very little. I have in the past tried planting trees but somehow I was not very successful, they were destroyed by young goats as I did not erect protective barriers. I also do not know the type of varieties to grow here but I can always learn that from my neighbours who have planted a lot of trees that are doing well here. Non-adopter B Olposimoru

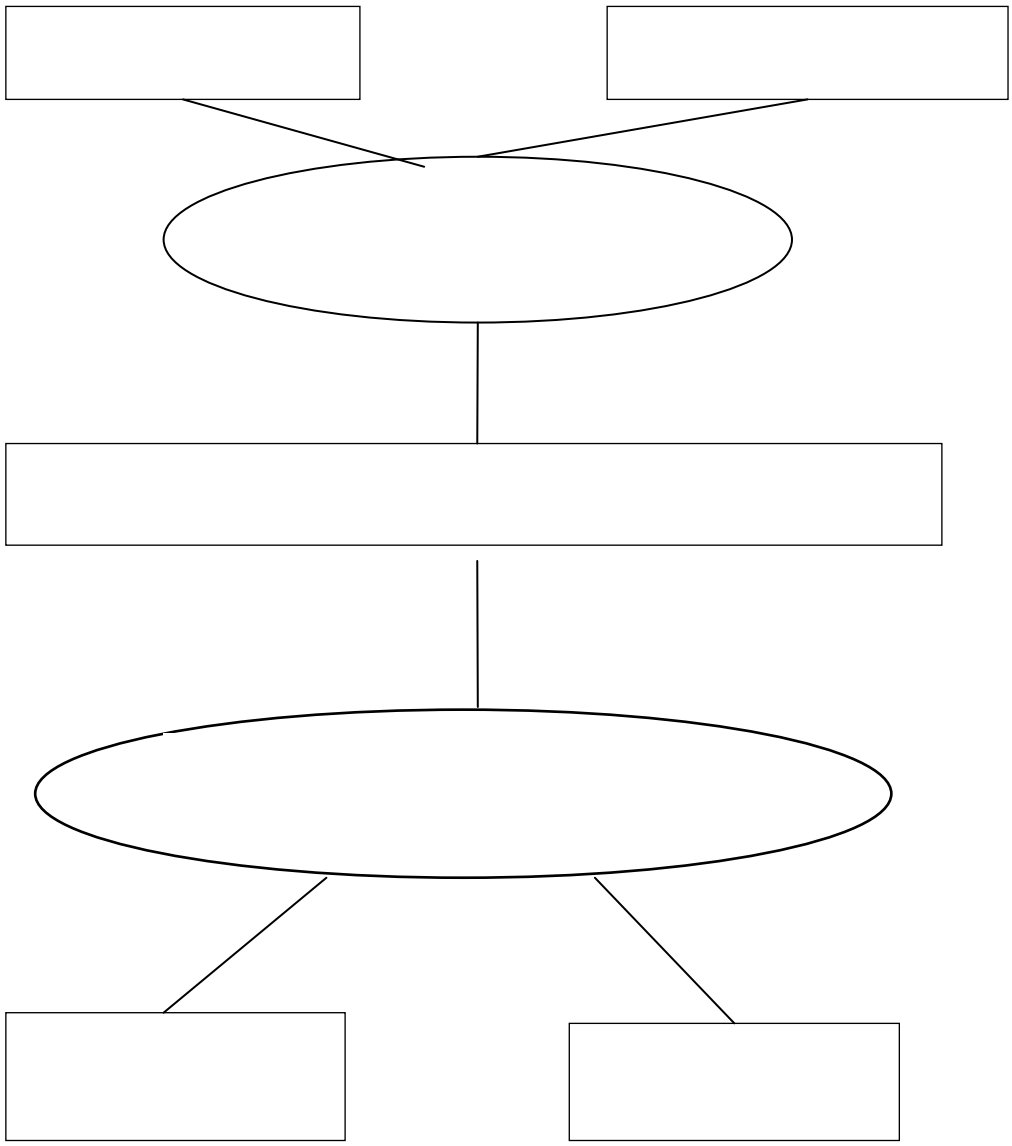

Figure 15: Basic knowledge on tree growing for farm-forestry non-adopters

This objective was informed by the fact that farm-forestry is a knowledge intensive practice which requires skills for both establishment and management of trees (Jerneck & Olsson, 2013). The results showed that whereas non-adopters had general knowledge and basic skills on tree growing adopters had more advanced skills and in depth knowledge necessary for establishment and management of trees. These results explain the results of the quantitative study that established that extension and social capital played a role in influencing the adoption of farm-forestry. It is mostly through extension and social networks that farmers acquire the skills and knowledge needed to practice farm-forestry.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the research findings

I. In summary the results of the quantitative study have revealed there was a statistically significant relationship between age-group, gender, extension contact, group membership and the educational level of farmers and adoption of the farm-forestry policy.

II. Farm-forestry adopters and non-adopters also significantly differed in their social capital dimensions

III. There was also a statistically significant relationship between land tenure and agricultural enterprise and adoption of the farm-forestry policy. While the t-test results revealed that the adopters and non-adopters significantly differed in their land sizes.

IV. The psychological factors of the farm-forestry adopters and non-adopters also differed significantly

V. The Tobit model also indicated that gender and land tenure status significantly predicted the adoption of farm-forestry policies.

VI. This study has revealed through the qualitative analysis that although farm-forestry non-adopters acknowledged the benefits they stood to derive from adopting farm-forestry, they also viewed farm-forestry as a long-term and risky investment.

VII. The qualitative study also revealed that farm-forestry non-adopters faced more challenges with regards to farm-forestry adoption than adopters with the major challenges being climatic barriers and resource constraints

VIII. Lastly the qualitative study revealed that farm-forestry adopters possessed more skills and knowledge on farm-forestry than the non-adopters.

5.2 Conclusions of the Study

Based on findings of this study the null hypotheses were rejected and the following conclusions were arrived at in line with the objectives of the study.

i. Some farmer-specific socio-economic characteristics such as age-group, gender, extension contact, group membership, education level and social-capital do have significant influence on the adoption of the Farm-forestry policy.

ii. Farm-specific socioeconomic characteristics such as land tenure, land size and agricultural enterprise significantly influence the adoption of the Farm-forestry policy.

iii. The psychological attributes of farm-forestry adopters and non-adopters were significantly different and this had an influence on the adoption of the farm-forestry policy.

iv. Land tenure and gender significantly predicted the adoption of the Farm-forestry policy.

5.3 Recommendations

The implication for the farm-forestry policy is that the policy should include more policy instruments other than laws and regulation in order to encourage farmers to adopt farm-forestry.

I. This study therefore recommends that trainings and forest extension services need to be provided to equip farmers with knowledge and skills needed for the adoption and management of farm-forestry.

II. Extension programmes on farm-forestry should focus on improving the attitude farmers have on farm-forestry so as to encourage more farmers to adopt the policy.

III. Extension programmes should also target female-headed households in order to impact them with skills on farm-forestry practices and build their capacity to adopt the policy.

IV. Extension officers should also target the least educated farmers when disseminating information on farm-forestry as they have been shown to have lower adoption rates.

V. Farmers should be encouraged to join farmer-groups as it is through these groups that peer to peer knowledge transfer take place.

VI. Extension services on farm-forestry can also be done through adopter farmers who can teach others in their social networks on farm-forestry and help increase adoption rates

VII. The county and national governments need to also ensure that farmers with financial and resource constraints are supported so as to reduce the hindrances to the adoption of farm-forestry.

VIII. Food insecure farmers need to be given special attention under the policy and encouraged to establish fast growing and drought resistant trees as it is clear that trees are already acting as a safety net for them in times of food insecurity.

IX. The government needs to support farmers with unsecure land tenure to acquire security so as to adopt the farm-forestry policy.

5.4 Recommendation for future research

Future research can consider measuring the impact of the adoption of farm-forestry on land degradation and agricultural production. Future research can also include the mapping of areas with very low tree cover as well as well as those with high tree cover and compare their agricultural production in order to make a strong case for the adoption of farm-forestry policies.

REFERENCES

Achalu, N., & Negash, M. (2006). Indigenous Agroforestry Practices and their implication on Sustainable Land use and Natural Resource Management: The case of Wonago Woreda . *Sustainable Land Use Forum.* Addis Ababa: Sustainable Land Use Forum.

Ademiluyu, I., Okude, A., & C, A. (2008). An Appraisal of land use and land cover mapping in Nigeria. *African Journal of Agricultural Research*, 25: 581-586.

Adesina, A. A., & Zinnah, M. M. (1993). Technology characteristics,farmer perceptions and adoption decisions a tobit model application in Sierra Leone. *Agricultural economics*, 9: 297-311.

Adesina, A. A., Mbila, D., Nkamleu, G. B., & Endamana, D. (2001). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agric. Ecosystems*, 23: 255-265.

Ajayi, O. C., Akinnifesi, F. K., Sileshi, G., Chakeredza, S., & Mgomba, S. (2009). Intergrating Food Security and Agri-environmental quality in Southern Africa: Implications for Policy. In I. N. Luginnah, & E. K. Yanful, *Environment and Health in Southern Africa: Mnaging an Emerging Crisis* (pp. 39-49). Hague: Springer Publishers.

Ajayi, O. C., Massi, C., Katanga, R., & Kabwe, G. (2006). Typology and characteristics of farmers planting improved fallows in Southern Africa. *Zambian Journal of Agricultural Sciences*, 20: 1-5.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 80: 179–211.

Ajzen, I. (2006). *Behavioral interventions based on the theory of planned behavior.*

Akbar, C., Baig, M. B., & Asif, M. (2000). Social aspects in launching projects in developing countries. *Science Vision*, 5:52-58.

Albrecht, A., & Kandji, S. (2003). Carbon sequestration in Tropical agroforestry systems. *Agriculture, Ecosystems and Environment*, 40: 15-27.

Amaza, P. S., & Tashikalma, A. K. (2003). Technical Efficiency of Groundnuts in Adamawa State, Nigeria. *Journal of Arid Agriculture*, 13: 127 – 1311.

Arnold , J. E. (1983). Economic considerations in agroforestry project. *Agroforestry Systems*, 299–311.

Asfaw, A., & Admassie, A. (2004). The Role of Education on the Adoption of Chemical Fertilizer under Different Socio-Economic Environments in Ethiopia. *Agricultural Economics*, 30: 215-228 .

Attride-Stirling. (2001). Thematic Networks: an analytical tool for qualiative research. *Qualiative Research*, 1(3) 385-405.

Bai, Z. G., & Dent, D. L. (2006). *Global Assesment of Land Degradation and Improvement: Pilot Study in Kenya.* Wageningen: FAO/ISRIC.

Bandiera, O., & Rasul, I. (2003). *Complementarities, Social Networks and Technology Adoption in Mozambique.* Unpublished manuscript London School of Economics.

Bandiera, O., & Rasul, I. (2006). Social Networks and Technology Adoption in Northern Mozambique. *Economic Journal*, 116: 869–902. .

Banful, A., Nkonya, E., & Oboh, V. (2010). *Constraints to Fertilizer use in Nigeria: Insights from Agricultural Extension Services.* Washington: International Food Policy Research Institute.

Barret, C. B., Place, F., Aboud, A., & Brown, D. R. (2002). The Challenge of Stimulating Adoption of Improved Natural Resource Management Practises in African Agriculture. In C. B. Barret, F. Place, & A. Aboud, *Natural Resource Management in African Agriculture:Understanding and Improving Practices* (pp. 1-22). Wallingford: CABI Publishing.

Bell, M. (2004). *Farming for all of us: Practical agriculture and cultivation of Sustainability.* Pennsylvania: Pennslyvania.

Bond, J. L., Kriesmer, S. K., Emborg, J. E., & Chadha, M. L. (2005). Understanding farmers' pesticide use in Jharkhand India. *Extension Farming Systems Journal*, 5 (1): 53-62.

Burt, R. (2000). The Network Structure of Social Capital. In R. Sutton, & B. Staw, *Research in Organizational Behavior* (pp. 345-423). Greenwich, CT: JAI Press.

Carson, R. T., & Sun, Y. (2007). The Tobit model with a non-zero threshold. *The Econometrics Journal*, 488-502.

CEEPA. (2006). *Climate change and African Agriculture.* Pretoria: University of Pretoria.

Chitakira, M., & Torquebiau, E. (2010). Barriers and Coping mechanisms relating to Agroforestry Adoptionby Small-holder farmers in Zimbabwe. *Journal of Agricultural education and extension*, 147-160.

Conley, T. G., & Udry, C. R. (2010). Learning about a New Technology: Pineapple in Ghana. *American Economic Review*, 100 (1): 35-69.

Creswell, J. W. (2014). *Research design : qualitative, quantitative, and mixed methods approaches.* California: SAGE Publications,.

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

Dewees, P. A. (1995). Trees and Farm Boundaries: Farm Forestry, Land Tenure and Reform in Kenya. *Journal of the International African Institute*, 65 (2) 217-235.

Di Falco, S., & Bulte, E. (2011). A dark side of social capital? Kinship, consumption, and savings. *Journal of Development Studies*, 47(8), 1128-1151.

Elbehri, A., Elliot, J., & Wheeler, T. (2015). Climate change, food security and trade: an overview of global assesment and policy insights. In A. Elbehri, *Climate change and food systems: Global assesments and implication for food security and trade.* Rome: FAO.

Fafchamps, M., & Minten, B. (2002). Returns to Social Network Capital Among Traders. *Oxford Economic Papers*, 54:173-206.

FAO. (1989). *Arid Zone Forestry: A guide for field technicians.* Rome: Food and Agriculture Organization of United Nations.

FAO. (2009, October 27). *FAOLEX Database: Agriculture (Farm-forestry Rules), 2009* . Retrieved June 12, 2016, from FAO: http://www.fao.org/faolex/results/details/en/c/LEX-FAOC101360/

FAO. (2010). *Global Forest Resources.* Rome: FAO.

FAO. (2015). *Climate Change and food systems: Global assesments and implications for food security and trade.* Rome: Food and Agriculture Organization of the United Nations.

Food and Agriculture organization of the United Nations. (2010). *Global forest resourses assesment.* Rome: FAO.

Franzel, S., & Scherr, S. J. (2002). *Trees on the Farm: Assessing the Adoption Potential of Agroforestry Practices in Africa.* Wallingford, UK: CAB International.

Franzel, S., & Wambugu, C. (2007). The adoption of fodder shrubs among small-hoders in East Africa: Key elements that facilitate widespread adoption. In M. D. Hare, & K. Wongpichet, *Forages: a pathway to prosperity for smallholder farmers* (pp. 203-222). Bangkok: Ubon Ratchathani University.

Garforth, C., Rehman, T., McKemey, K., Tranter, R. B., Cooke, R. J., Yates, C. M., et al. (2004). Improving the design of knowledge transfer strategies by understanding farmer attitudes and behaviour. *Journal of Farm Management*, 12:17-32.

Garrity, D., Akinnifesi , F., Ajayi, O., Weldesemeyat, S., Moyo, J., & Kalinganire, A. (n.d.). Evergreen Agriculture;.

GoK. (2012). *Forests Act.* Nairobi: National Council for Law Reporting.

Government of India Department of Agriculture & Cooperation Ministry of Agriculture. (2014). *National Agroforestry Policy.* New Delhi: Government of India.

Government of Kenya. (2012). *National Climate Change Action Plan2013-2017* . Nairobi: GOK.

Grootaert, G., Narayan, D., Nyhan, J., & Woolcock, M. (2004). *Measuring Social Capital : An Integrated Questionnaire. World Bank Working Paper;No. 18.* Washington, DC: World Bank.

Herath, C. S. (2013). Does intention lead to behaviour? A case study of the Czech Republic farmers. *Agric.. Econ. Czech*, 59 (13):143-148.

Holloway, G., Nicholson, C., Delgado, C., & Staal, S. (2003). A revised Tobit procedure for mitigating bias in the presence of non-zero censoring with an application to milk-market participation in the Ethiopian highlands. *Agricultural economics*, 32: 76-85.

IPCC. (2000). *Land use change and Forestry. A speacial report of the IPCC.* Cambridge: Cambridge University.

IUCN. (2019). International Union for the Conservation of Nature. Retrieved August 20, 2019, from https://www.iucn.org/resources/issues-briefs/deforestation-and-forest-degradation

Jama, B., & Zeila, A. (2005). *Agroforestry in the drylands of Eastern Africa: a call to action. Icraf working paper* . Nairobi: World Agroforestry center.

Jerneck, A., & Olsson, L. (2013). More than trees! understanding the Agroforestryadoption gap in subsistence agriculture:Insights from narrative walks in Kenya. *Journal of Rural Studies*, 32:114-125.

Kabede, A. Z., Melchinger, A. E., Cairns, J. E., Araus, J. L., Makumbi, D., & Atlin, G. N. (2013). Relationship of line perse and testcross performance for grain yield of tropical maize in drought and well-watered trials. *Journal of Crop Science*, 53:1228–1236.

Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from Rural Tanzania. *Technological Forecasting and social change*, 80(3), 525-540.

KFWG/DRSRS. (2006). *Changes in Forest Cover in Kenya's Five "Water Towers" 2003-2005.* Nairobi: KFWG/DRSRS.

Kiptot, E., & Franzel, S. (2011). Gender and agroforestry in Africa: a review of women's participation. *Agroforestry systems*, 20: 35-58.

KNBS; SIDA. (2013). *Exploring Kenya's Inequality: Pulling apart or pooling together? Narok County.* Nairobi: Kenya National Bureau of Statistics.

Masangano, C., & Mthinda, C. (2012). *Pluralistic Extension in Malawi.* IFPRI.

Matata, P., Ajayi, O. C., Oduol, P. A., & Agumya, A. (2010). Social-economic factors influencing adoption of improved fallow practices among small-holder farmers in Western Tanzania. *African Journal of Agricultural Research*, 12: 818-823.

McCarthy, J. S., Canziani, O. F., Leary, N. A., Dokken, D. J., & White, K. S. (2001). *Climate Change 2001:Impacts, Adaptation, and Vulnerability.* Cambridge: Cambridge University Press.

Meijer, S. S., Catacutan, D., Sileshi, G. W., & Nieuwenhuis, M. (2015). Tree planting by smallholder farmers in Malawi: Using the theory of planned behaviour to examine the relationship between attitudes and behaviour. *Journal of Environmental Psychology*, 43: 1-12.

Mercer, D. (2004). Adoption of Agroforestry innovations in the tropics: a review. *Agroforestry systems*, 40: 311-328.

Ministry of Environment and Forestry. (2018). *Forest Resources Management and Logging activities in Kenya.* Nairobi: Government of Kenya.

Mugenda, O. M., & Mugenda, A. G. (2003). *Research Methods:Quantitative and Qualitative Approaches.* Nairobi: ACTS Press.

Muneer, S. (2008). Factors Affecting Adoption of Agroforestry Farming System as a Mean for Sustainable Agricultural Development and Environment Conservation in Arid Areas of Northern Kordofan State, Sudan. *Saudi Journal of Biological Sciences* , 30: 95-110.

Mwase, W., Sefasi, A., Njoloma, J., Nyoka, B., Mandua, D., & Nyaika, J. (2015). Factors affecting adoption of Agroforestry and Evergreen Agriculture in Southern Africa. *Environment and Natural Resource Research*, 43: 148-152.

Narok County Intergrated Development Plan 2018-2022. (2018). *Narok County Intergrated Development Plan 2018-2022.* Narok: Narok County Government.

Oeba, V., Otor, S., Kung'u, J., & Muchiri, M. (2012). Modelling Determinants of Tree Planting and retentionon Farm for improvement of forest cover in central Kenya. *Forestry*, 20: 1-14.

Ogweno, D. O., Imo, M., Matano, A., & Orinda, B. (2001.). Evaluation of the management and sustainability of private tree nurseries in Kipkaren river catchment, Kenya. *1st National Scientific Conference, Lake Victoria Environmental Management Project.* Kisumu.

Ojwang', G., Agatsiva, J., & Situma, C. (2010). *Analysis of Climate Change and variability risks in small holder sector: case studies of Laikipia and Narok District representing major agro-ecological zones in Kenya.* rome: FAO.

Osuntogun, A., Adeyemo, R., & Anyanwa, E. (1986). The Adoption of Innovation by Cooperative farmers in Nigeria. *Tropical Agriculture*, 63:158-160.

Otsuki, T. (2010). *Estimating Agroforestry Effects on Agricultural Productivity in Kenya: An Application of a Treatment Effect Model.* Osaka: Osaka University.

Regassa, S., Givey, C., & Gina, E. (2010). *The rain doesnt come on time anymore. Oxfam International Report.* Oxfam.

Reij, C., Tappan, G., & Smalle, M. (2009). *Agroenvironmental Transformation in the Sahel. Another kind of 'Green Revolution'.IFPRI Discussion paper 00914.2020 Vision Initiative.* Washington: International Food Policy Research Institute.

Roca, A. (2011). *A socio-psychological study of adoption of farmers' agro-biodiversity friendly practices in Flanders (Master's Dissertation).* Retrieved from Ghent University Library: http://lib.ugent.be/fulltxt/RUG01/001/789/889/RUG01-001789889_2012_0001_AC.pdf

Rogers, E. M. (2003). *The diffusion of innovations 5th Edition.*

Sabatini, F. (2006). The Empirics of Social Capital and Economic Development: A Critical Perspective. *FEEM Working Paper No. 15*.

Sanchez, P. A., & Jama, B. I. (2002). Soil fertility replenishment the take off East and Southern Africa. In B. Vanlauwe , *Integrated plant nutrition management in Sub-Saharan Africa from concept to practice.* (pp. 23-45). Washington: CABI International.

Sena, K. (2006). Mau forest: Killing the goose but still wanting the golden eggs. *Indigenous affairs*, (4), 30-35.

Sikuku, F. O., Apudo, M. G., & Ototo, G. O. (2014). Factors Influencing adoption of farm-forestry in Lugari District, Kakamega County, Western Kenya. *Journal of Agriculture and Veternary Science*, 40: 06-13.

Sood, K. K., & Mitchell, C. P. (2004). Do socio-psychological factors matter in agroforestry planning? Lessons from smallholder traditional agroforestry systems. *Small-scale forestry*, 3(2):239-255.

Stubenitsky, K., & Mela, D. (2000). UK consumer perceptions of starchy foods. *British Journal of Nutrition*, 83:277-285.

Syaka, S., & Castillo, P. N. (2003). Trees oustide Forests: Contributing towards Sustsinable Development. *XII World Forest Congress.* Quebec: FAO.

Tengnas, B. (1994). *Agroforestry Extension Manual for Kenya.* Nairobi: ICRAF.

Thangata, P. H., & Alavalapati, J. R. (2003). Agroforestry adoption in southern Malawi: the case of mixed intercropping of Gliricidia sepium and maize. *Agricultural Systems*, 78(1), 57-71.

Tiffen, M., Purcell, R., Gichuki, F., Gachene, C., & Gatheru, J. (1996). *National Soil and Water Conservation Programme.* Stockholm: SIDA.

UCLA: Statistical Consulting Group. (2019). *Tobit Regression : Stata Annotated Output*. Retrieved June 3, 2019, from UCLA Institute for Digital Research and Education: https://stats.idre.ucla.edu/stata/output/tobit-regression/

UN. (2011, November 28). *COP 17*. Retrieved August 30, 2016, from United Nations Climate Change: https://unfccc.int/process-and-meetings/conferences/past-conferences/durban-climate-change-conference-november-2011/cop-17

Verchot, L. V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., et al. (2007). Climate Change: Linking adaptation and mitigation through agroforestry . *Mitigation and adptation strategies for Global change*, 901-918.

Wambugu, C., Franzel, S., Tuwei , P., & Karanja , G. (2001). Scaling up the use of fodder shrubs in central Kenya. *Development in Practice*,40 (1) 487-494.

Weir, S., & Knight, J. (2000). *Adoption and diffusion of agricultural Innovations in Ethiopia: The role of Education. CSAE Working Paper Series 2000-04.* Oxford: Centre for the Study of African Economies, University of Oxford.

Zerihun, M., Muchie, M., & Worku, Z. (2014). Determinants of agroforestry technology adoption in Eastern Cape Province, South Africa. *Development Studies Research*, 43: 382-394.

Zomer, R., Trabucco, A., Coe, R., & Place, F. (2005). *Trees on farms:Analysis of Global Extent and Geographical patterns of agroforestry. Icraf Working Paper.* Nairobi: ICRAF.

Zubair, M., Garforth, C., Hussain, S. B., Zahid, D. M., Baloch, M. S., Shah, F. R., et al. (2011). Farm Forestry in Pakistan: An Application of Theory of Planned Behavior by Probing into the Measurement Issues . *Pak. J. Bot*, 43 (1):705-714.

Zubair, M., & Garforth, C. (2006). Farm level tree planting in Pakistan: the role of farmers' perceptions and attitudes. *Agroforestry systems, 66* (3), 217-229.

APPENDICES

3.13 APPENDIX A: Small-Scale Farmer's Questionnaire

I am Cecilia Naeku a graduate student of Egerton University carrying out a research on the influence of socio-economic characteristics socio-psychological factors on the adoption of farm-forestry. You have been identified as a useful informant to assist me to achieve this mission. Your participation is voluntary and you are assured that the information you provide will be treated with confidentiality and used for the sole purpose of research. Your cooperation will be highly appreciated.

Instructions: the interview should be administered only to the household head.

Questionnaire serial number [……]

1. Ward […….....]

2. Date of interview […….]

3. Household ID…….]

PART 1: SOCIO-ECONOMIC CHARACTERISTICS

A1: Farmer-specific characteristics

1. Household head characteristics

Age group	**Gender**	**Education level**
1=20-25 2= 26-30 3 =31-35 4=36-40 5=41-45 6=46-50 7= 51-55 8= 56-60 9= 61-65 10= 65+	1=Male [ ] 0=Female [ ]	1= No formal education 2= primary 3= secondary 4= college 5= university 6. Other specify

2. Does the household have any **off-farm income**? 1=Yes [ ] 0= No [ ]

3. Has anyone in the household received any **training/extension advice**? 1= Yes [] 0= No [ ]

Household member trained 1=household head 2=spouse 3= son 4= daughter 5= other relative	Were you ever trained on farm-forestry? 1=yes 0= no	What were you taught about farm-forestry 1= importance of planting trees 2= ideal species, planting and tree spacing 3= tree product marketing 4= tree diseases, pest and control	Training provider 1= Government extension officers 2=NGO 3= Private input providers 4=other specify

4. Farmer's social capital

A. Groups and group homogeneity

i. . I would like to start by asking you about the groups or organizations, networks, associations to which you or any member of your household belong. These could be formally organized groups or just groups of people who get together regularly to do an activity or talk about things. How many such groups are you or any one in your household a member? _____

ii. Of all these groups to which you or members of your household belong, which one is the most important to your household?

_____ [Name of group]

Group homogeneity:

iii. Thinking about the members of this group, are most of them of the same….

	1= Yes 0= No
A. Religion	
B. Gender	
C. Ethnic background/tribe	

iv. Do members mostly have the same?

	1 =Yes 0= No
A. Occupation	
B. Educational background or level	

v. Does this group

Work with or interact with groups *within* the village? 0= No [ ] 1=Yes [ ]	Work with or interact with groups *outside* the village? 0=No [ ] 1=Yes [ ]	Work with or interact with government officials or NGOs? 0=No [ ] 1= Yes [ ]

B. **Network of friends and network resources**

i. About how many *close friends* do you have these days? These are people you feel at ease with, can talk to about private matters, or call on for help _____

ii. If you suddenly needed to borrow a small amount of money [enough to pay for expenses for your household for one week], are there people beyond your immediate household and close relatives to whom you could turn and who would be willing and able to provide this money?

a. Definitely

b. Probably

c. Unsure

d. Probably not

e. Definitely not

iii. In general, do you agree or disagree with the following statements?

	1 Agree strongly 2 Agree somewhat 3 Neither agree or disagree 4 Disagree somewhat 5 Disagree strongly
A. I have gained resources through my network of close friends	
B. I have gained information and knowledge through my network of close friends.	
C. My network of close friends provides	

me with access to my close friends farming experience and 'know-how'.	
D. I have mostly learned about farm-forestry from my network of close friends	
E. My network of close friends has influenced my adoption of farm-forestry	

5. B1: Farm-specific Characteristics

Land tenure 1=owned with title deed 2=owned without title deed 3= Rented 4=owned by parents 5=Communal/ government/ cooperative	**Land size (hectares)**	**Agricultural enterprise practiced** 1=Crop Farming [ ] 2=Pastoralism [ ] 3= Agro-pastoralism [ ] 4=mixed farming [ ]

PART 2: FARM-FORESTRY ADOPTION

i. Have you planted trees on your farm? 1=yes 0=no

ii. How many trees have you planted [……]

iii. Have you intentionally retained indigenous trees on your farm? 1=yes 0= no

iv. How many indigenous trees have you intentionally retained on your farm? [……]

PART 3: SOCIO-PSYCHOLOGICAL FACTORS

A3: Attitude

Belief strength

Likert items	Scale				
"Planting trees on my farm will…"	1= Strongly Disagree	2= Disagree	3=Neither agree nor disagree	4=Agree	5=Strongly Agree
1. Increase my income					
2.increase availability of fuel wood and furniture wood					
3.Control erosion					
4. Provide shade for human beings and animals					
5. Planting trees on my land is an important source of fruits for my household					
6. Planting trees on my land will improve soil fertility					
7. Cause hindrance in agricultural					

operations					
8. Incur more cost					
9. Cause shade that will reduce the yield of crops					
10. Increase pest outbreaks					
11. Take up too much space					
12. Lead to scarcity of water on my land					
13. cause hard pans					

Outcome evaluation

Likert item	Scale				
"For me to…"	1= Very Bad	2= Bad	3=Neutral	4=Good	5= Very Good
1.Have more income is					
2.Have more fuel wood and furniture wood is					
3.Have controlled erosion is					
4.Have more shade is					
5.Have more fruits is					
6. Have improved soil fertility is					
7.experience hindered agricultural operation is					
8. incur more costs is					
9. experience reduced yields is					
10.experience more pest					

outbreaks is					
11. less space on my land is					
12. experience more scarcity of water on my land is					

B3: Subjective Norms

Normative beliefs

Likert Item	Scale				
	1= strongly disagree	2= disagree	3=Neither agree nor disagree	4= Agree	5=Strongly agree
1. My immediate family members think I should plant trees on my land					
2. My extended family members think I should plant trees on my land					
3. My farmer group thinks I should plant trees on my land					
4. My friends think I should plant trees on my land					
5. My fellow farmer thinks I should plant trees on my land					
6. The village chief/ elder thinks I should plant trees on my land					
7. Most of the people in my village are planting trees on their farm					

Motivation to comply

Likert Items	Scale				
"Generally speaking I want to …."	1= never	2= Rarely	3= sometimes	4= often	5= very much
1.Do what my immediate family members think I should do					
2.Do what my extended family members think I should do					
3. Do what my farmer group think I should do					
4. Do what my friends think I should do					
5. Do what my fellow farmer think I should do					
6. Do what my village chief/elder think I should do					
7. Be like the other people in my village					

C3: Perceived Behavioural control

Control beliefs

Likert Items	Scale				
	1= strongly disagree	2= disagree	3=neither agree nor disagree	4= agree	5= strongly agree
1.Tree seeds and seedlings are					

easily available to me					
2. Water is sufficiently available on my land					
3. I have enough time to carry out all my farming activities					
4. The market for tree products is unavailable					
5. Farm-forestry is a long term business					
6. I often encounter livestock browsing on my land					
7. Rainfall is irregular and inadequate					
8. I often encounter termites on my land					
9. I have no knowledge on the tree species suitable for my farm					

Power of control beliefs

Likert items	Scale				
	1= very difficult	2= difficult	3= neutral	4= easy	5= very easy
1. If tree seeds and seedlings are easily available it will make planting trees…					
2. If water is sufficiently available, it will make planting trees…					

3. If I have enough time to carry out all my farming activities, it will make planting trees…					
4. If the market for tree products is unavailable, it will make planting trees….					
5. If Farm-forestry is a long term business, it will make practising it….					
6. If I often encounter livestock browsing on my land, it will make planting trees…					
7. If Rainfall is irregular and inadequate, it will make planting trees…					
8. If i encounter termites on my land, it will make planting trees….					
9. If I have no knowledge on the tree species suitable for my farm, it will make tree planting…					

3.14 APPENDIX B: Interview Guide for Farm-forestry Policy Adopters

Ward […….....]

Household ID […….]

Number of trees per acre […….]

1. What are your thoughts about farm-forestry?

2. What challenges have you experienced since you started practicing farm-forestry?

3. What kind of information/ Knowledge do you have regarding farm-forestry?

3.15 APPENDIX C: Interview Guide for Farm-forestry Policy Non-Adopters

Ward […….....]

Household ID […….]

Number of trees per acre […….]

1. What are your thoughts about farm-forestry?

2. What are the barriers that have hindered you from planting trees/ practicing farm-forestry?

3. What kind of information/ Knowledge do you have regarding farm-forestry?

3.16 APPENDIX D: Abstract for the Journal publication

Influence of Psychological Factors on the Adoption of Farm-Forestry Practices among Small-Scale Farmers in Narok-North Sub-County, Kenya

Cecilia Naeku, Prof. Margaret Ngigi, Prof. Mark Okere

Abstract

The objective of this paper is to examine the psychological factors that influenced the adoption of farm-forestry practices among small-scale farmers. Despite the numerous benefits farmers can derive from incorporating farm-forestry practices in their farmlands, the adoption of such practices has remained sub-optimal. Kenya's government has over the years implemented projects and enacted farm-forestry policies to encourage farmers to incorporate trees on farms. The researcher used an explanatory sequential mixed method research design with a sample size of 110 small-scale farmers in Narok-North Sub-County. Proportionate sampling technique was used to acquire the sample sizes of the different wards of the Sub-County while simple random sampling was used to obtain the research participants. Semi-structured questionnaires were administered to research participants to generate information on the psychological factors that were measured on a 5-point Likert scale. The results of the Mann-Whitney tests showed that farm-forestry adopters and non-adopters differed significantly in the various constructs that were used to measure attitude. The adopters had a more favourable attitude towards farm-forestry than the non-adopters. They also differed in their subjective norms in which farm-forestry adopters had social networks that supported the practice of farm-forestry. The results also showed that farm-forestry adopters indicated that they faced certain barriers that hindered their adoption of farm-forestry.

Key Terms: Psychological factors, adoption, small-scale farmers, farm-forestry practices

3.17 APPENDIX E: Research Permit

THIS IS TO CERTIFY THAT:
MISS. CECILIA PERERUAN NAEKU
of EGERTON UNIVERSITY, 0-20100
Nakuru,has been permitted to conduct
research in *Narok County*

on the topic: *SOCIO-ECONOMIC AND PSYCHOLOGICAL FACTORS INFLUENCING SMALL-SCALE FARMERS' ADOPTION OF FARM FORESTRY POLICY IN NAROK NORTH SUB-COUNTY, KENYA*

for the period ending:
5th February,2020

.....
Applicant's Signature

Permit No : NACOSTI/P/19/10894/27940
Date Of Issue : 6th February,2019
Fee Recieved :Ksh 1000

.....
Director General
National Commission for Science, Technology & Innovation

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