INFLUENCE OF GOVERNMENT POLICIES AND HOUSEHOLD CHARACTERISTICS ON THE ADOPTION OF AGROFORESTRY PRACTICES IN KIIRUA, KIBIRICHIA AND RUIRI WARDS, MERU COUNTY, KENYA

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DECLARATION

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

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DEDICATION

I dedicate this work to my family members: Claire Kagwiria, my sister and Brian Koome, my son for their immense support they accorded me throughout this study.

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ABSTRACT

The land in Kiirua, Kibirichia and Ruiri wards of Buuri sub-county in Meru County is fertile and with a high rainfall, this has encouraged a concentration of population and farming leading to deforestation and soil erosion. Agroforestry practices can allow the farmers to grow crops without damaging the vegetation that provides a cover for the soil and also the trees can provide fuel wood, food and timber to the growing population. Despite government and non-governmental organizations efforts to encourage Agroforestry in the area, few farmers have adopted this technology causing the land to degrade further. This study aimed at studying government policies and household characteristics affecting farmers' adoption of Agroforestry technologies. The objectives of the study were to: (i)assess how household characteristics influence adoption of agroforestry practices, (ii) establish how farm size influence the adoption of agroforestry practices, (iii) evaluate how training influences the adoption of adoption of agroforestry practices, (iv) establish how input provision to farmers influences the adoption of agroforestry practices, and (v) determine how collective action influences the adoption of agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya. The descriptive research design was used. The study targeted 895 households in three wards of Buuri sub-county. A structured questionnaire was used to collect data from 268 households. Stratified random sampling technique was used, the study area was divided into wards and each ward formed the strata. The household were then selected at random in each stratum. Data were analyzed using descriptive (frequency distribution, means, mode and standard deviations) and inferential statistics (linear regression and chi-square tests) in a Statistical Package for the Social Sciences (IBM SPSS version 26). The results of the study indicated that the level of farmers of agroforestry practices was moderate (M=2.48, SD=1.90) on a scale of 1 to 5. The largest group of farmers had low level of adoption and these results were significant statistically (χ^2 105.59, df, $p< 0.001$). No statistical significant ($p>0.05$) influences were found between the household characteristics (education and household size) and adoption of Agroforestry practices. Land size was found to have a statistical significant influence ($\beta=0.365$, t-6.392, $p<0.001$).Government policy factors were found to have statistical significant influences ($p<0.05$), specifically farmers training influenced ($\beta=0.982$, t=85.42, $p<0.001$), input provision to famers ($\beta=0.327$, t=5.644, $p<0.001$), and collective action ($\beta=0.418$, t=7.497, $p<0.001$) the adoption of Agroforestry by farmers. The study concluded that: Shortage of land, lack of knowledge, lack of collective action, training, monetary and physical inputs influenced the adoption of agroforestry practices in Buuri sub-county. The study recommended that the government organize sensitization forums on Agroforestry matters, train both extension officers and farmers and also to encourage farmers to form groups to ease in credit access and information dissemination.

DEFINITION OF TERMS

Agroforestry: land use systems and techniques where woody perennials, trees, shrubs, plans, bamboo are deliberately combined with agricultural crops on same land management unit and or animals in some form of spatial arrangement or temporal systems. Agroforestry is a sustainable land management system which increase the yield of the land by combining the combination of crops including tree crop, and or animals simultaneously and or sequentially on the same unit of land, (Olujobi, 2018)

Households: Collectively, all the persons who live in a given establishment, (Mulu, 2014). This denotes respondents in the study area belonging to the same house and family.

Adoption: Denotes decision to make full use of an innovation as the best course of action available (Rogers, 1995). This expresses the acceptance of an innovation by an individual farmer, where the innovation is agroforestry which helps to cope with the impact of climate change.

Social economics factors: Social and economic experiences and realities that contribute to one's personality, attitudes and lifestyle, (Obeng & weber, 2014). It denotes the realities that contribute to the personality, attitude and lifestyle of the respondents in the study area.

ABBREVIATIONS AND ACRONYMS

CIDP	County Integrated Development Plan
KBS	Kenya Bureau of Statistics
SDGs	Sustainable Development Goals

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This study was an assessment of government policies and farmers' socio-economic factors influencing the adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya. The independent variables included: (i) government policies that was indicated by: farmers training in skills and knowledge, input provision, and collective action groups and (ii) farmers socio-economic factors: household tree species preferences, farm size, and household characteristic. The adoption of Agroforestry practices was indicated by number of trees planted, number of species planted and the number of the Agroforestry practices undertaken on the farms. The study area is degraded due to soil erosion and lack of plant cover, and it has been recognized that Agroforestry practices can aid in reducing soil loss from the farms and in the process also provide an income to the farmers.

This chapter introduces the topic under study, how government policies and household characteristics influence the adoption of selected agroforestry practices in Kiirua, kibirichia and Ruiri wards, Meru County. The chapter contains background of the study, statement of the problem, purpose of the study, study objectives, research questions, significance of the study, delimitations and limitations, assumptions of study, theoretical frame work and conceptual framework.

1.2 Background of the Study

Agroforestry is a long-established farming practice in many parts of the world for livelihood diversification and climate change (Mugure *et al*., 2013). Thakur, Malik, Singh and Oraon (2018) defines agroforestry as a set of land-use practices that

includes combination of trees, agricultural crops and/or animals on the same land management unit in some form of spatial arrangement or temporal sequence. Agroforestry systems consist of cultivation activities that combines arboreal species with either annual or perennial crops in a way which is looking for the optimal use of land together with the maximum income per unit area.

Farmers in rural areas throughout the world in recent years have been facing massive challenges including population upsurge, poverty increase and food insecurity, climate change among others. Gradually many farmers are turning to agroforestry practices as alternative means of improving their state of affairs. Ednam *et al.,* (2013) argues that in order to experience sustainable land management practices, looking into land degradation and deterioration of soil productiveness, in the near past there has been a growing attention in the execution and campaigning for agroforestry practices amongst smallholder farmers especially in the third world countries. Socio-economic factors like; gender, farm size, access to capital and incentives contribute to adoption of agroforestry.

Agroforestry adoption creates a wide range of gains and environmental benefits than traditional kinds of annual crop cultivation (Bijarfas *et al.*, 2015). Agroforestry has several advantages such as improvement in soil fertility which increases crops yields, extending the harvesting season and improving the quality of produce as well as increasing the income of rural communities. For a community to experience economic development process, the capital aspect is an important aspect. Socio-economic factors like income, occupation, education level, farm size and household size, are linked to agroforestry adoption among smallholder farmers. Makori, (2017) argues

that income, occupation and education levels influence tree planting in Kenya. On the other hand, Chitere (1985) reveals that land size has an influence on agroforestry adoption in Central Kenya.

Farm size has a positive relationship with the smallholders' choice to practice agroforestry observed (Olujobi, 2018). He also noted that age has influence on adoption of agroforestry. Factors like availability of labor, innovativeness of a farmer, also influence the adoption of agroforestry. In addition, he argues that formal and informal training has the prospective to rise the rate of adoption of agroforestry by directly increasing awareness. The level of education and exposure to information influences farmers to embrace and practice agroforestry.

In some instances, some traditional beliefs influence acceptance of Agroforestry practices. For instance, Gichuki and Njoroge (1989) argued that in Kenya, some communities, women are not allowed to plant trees because doing so is believed to be an act of ownership over land. In some other communities, trees belonged to men irrespective of who plants them. Kerkhof (1992) in western parts of Kenya for instance there are different tree species for men and women. It is not acceptable for women to plant certain tree species, because it is believed if they do so they will become barren. Some tree species are linked with certain beliefs and therefore, cannot be planted at all by community members even if they are beneficial in any way.

According to Sleshi *et al.*, (2007) argued that if Agroforestry is properly planned and carried out, particularly at landscape level, enormous benefits which play a part to the sustainability of residents and, on a greater magnitude, to ecosystems on which the

local communities rely upon for their livelihoods will be enhanced. On the other hand, the environmental and economic services perhaps could not be valued by the market, implying that development actors and farmers must take up all the production cost, though the entire nation benefits in the long run. Introducing financial aid and incentives to farmers who practice tree cultivation in their farms can be regarded as a system of payment for environmental services, which will motivate more people to embrace agroforestry.

The integration of agroforestry into national sustainable development can assist in achieving sustainability. Cheik (2015) further affirms that progress has been made in integrating sustainable development goals into forest sector. Forests and agroforestry if well embraced and managed, play a role in achieving the United Nations, Sustainable Development Goals (SDGs), including other globally agreed development goals. Agroforestry makes an enormous impact on the Sustainable Development Goals for instance, it eliminates hunger and poverty while ensuring environmental sustainability. On the other hand, agroforestry has an indirect role assisting to meet other SDGs, through their social, economic and environmental services. For instance, agroforestry minimizes child mortality rate and enhances human health through its contribution to food security, providing medicines, as well as a source of income. Agroforestry Practices, have potential to uplift the socioeconomic conditions of the farmers. Maren and Carolyn (2014) affirm that agroforestry enhances socioeconomic livelihood of rural farmers by enhancing income earning potentials and overall food and nutritional security employment.

Agroforestry systems improve the microclimate which in turn improves the adaptive capacity of land owners to climate change, (Adedayo and Oluronke 2014). They further argued having or planting trees amongst croplands may improve on agricultural products thus translating to increased source of income which improves the social economic resilience. Planting or including trees into the Agri systems where trees are planted close to each other and pruned or browsed intensively may assist or improve economic benefits. Fodders grown by the farmers increases milk production and may be substitute for relatively expensive purchased diary meals, thus improving the farmers income. The specific types of agroforestry practices include improved fallows, taungya farming, home gardens, alley cropping, growing multipurpose trees and shrubs on farmland as well as boundary planting.

Agroforestry practice offers many benefits and opportunities that include crops yield, livestock, soil fertility and water availability improvements argued, (Mgeni, 2013). This facilitates diversification of household revenue sources through the timber products and non-timber products hence enhancing landscape by promoting biodiversity and carbon Sequestration (a natural way or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form). Arun *et al.,* (2013) further argues that gaining production advantages using diversity of crop species within a cropping system has been the major objective of agroforestry practice. Farmers who have effectively adopted agroforestry practices have experienced high crop production and high revenue generations.

1.3 Statement of the Problem

Declining soil fertility has become a critical problem affecting agricultural productivity and human welfare in Kenya. The continued degradation of land on a

large scale and scarcity of fertile land in Kenya poses a serious threat to socioeconomic development, environmental conservation and food security. Community forests have been exploited by residents for charcoal, firewood, timber, grazing animals and for cultivation purposes. This has led to destruction of water catchments areas and destruction of trees species. Unpredictable climate changes have made it worse for farmers who rely on rains for farming.

Few studies have been done on the influence of government policies and household characteristics on adoption of agroforestry practices in Kenya. This study therefore seeks to assess the influence of government policies and household characteristics (household preference, income levels, education levels and farm size) on selected adoption of agroforestry practices in Kiirua, kibirichia and Ruiri wards Meru County.

1.4 Purpose of the Study

The purpose of this study was to assess the influence of government policies and household characteristics on the adoption of selected agroforestry practices in Kiirua, kibirichia and Ruiri wards, Meru County, Kenya

1.5 Objectives of the Study

1.5.1 General Objective of the Study

The main objective of the study was to assess the influence of government policies and household characteristics on the adoption of Agroforestry practices in Kiirua, kibirichia and Ruiri wards, Meru County.

1.5.2 Specific Objectives

The study was guided by the following specific objectives:

(i) Assess how household characteristics influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya;

(ii) Establish how farm size influence the adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya;

(iii) Evaluate how training influences the adoption of adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya;

(iv) Establish how input provision to farmers influences the adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya;

(v) Determine how collective groups action influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya.

1.6 Research Questions

In respect to the above problem statement, the study sought to answer the following research questions:

(i) To what extent does household characteristics influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya?

(ii) How does farm size influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya?

(iii) How does farmers training influence the adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya?

(iv) To what extent does input provision to farmers influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya?

(v) How does collective group's action influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya?

1.7 Significance of the Study

The findings from this study can make a significant contribution to Agroforestry promotion and provide useful feedback to scholars, policy makers in terms of developing strategies specific to different regions. Further the study findings may enable the farmers adopt Agroforestry practices that facilitate sustainable farming practices. The County Government can utilize the findings of this research in reviewing the CIDP programs that support Agroforestry practices and create legislations that facilitate easy adoption and utilization of the selected Agroforestry practices in the county.

1.8 Scope of the Study

This study focused on how government policies and household characteristics influence the adoption of selected agroforestry practices in Kiirua, kibirichia and Ruiri wards, Meru County. Kiirua, kibirichia and Ruiri wards, are located within Meru County. The focus was guided by the few studies done on social economic factors that influence adoption of agroforestry practices in Kenya. The three wards have 41,470 total population, (KBS 2013). The total number of people practicing agriculture are 895 households. These wards are dominated by wheat and horticulture farming. The study was limited to Kiirua, kibirichia and Ruiri wards Meru County.

1.9. Delimitation

The study was limited to government policies and household characteristics and how they influence adoption of selected agroforestry practices in Kiirua, kibirichia and

Ruiri wards, Meru County, despite other factors which influence adoption of agroforestry practices.

1.10. Limitations

The limitations the researcher encountered during the study included a limited budget considering the intensity of the details and materials to be developed for a detailed document and time constraints.

1.11. Assumptions of the Study

The researcher assumed that the respondents gave firsthand information without holding back and the targeted population understood the magnitude of the study and answered the questions correctly.

1.12. Theoretical Framework

The theoretical framework presents the relevant theories that clarified why the research problem under the study exists. Theory that supported this research study was adoption behavior model. This theory was relevant to this study because it explained how Agroforestry adoption is a mental decision based on needs, knowledge and perception and diffusion and innovation model distinguished the outlook that influences adoption: identifies qualities of the innovation; sort of innovation choice; communication channel; nature of the social framework; and the degree of progress of agent promotion endeavors.

1.12.1. Adoption Behavior Model

Agroforestry adoption is a mental decision based on needs, knowledge and perception, (Carolin *et al.,* 2018). Adoption behavior model is beneficial and suitable to this study (Tolman, 1967). This theory is based on adoption behavior of a person

who relies on socioeconomic and environmental aspects, consequently the main reason of taking on a new technology is endogenous to the entirety of the interrelating aspects of the state of affairs.

Adoption is influenced by many factors such as socio-economic, environmental and mental process affirms, (Ngoni, 2018). These factors are intervened by variables that include knowledge about agroforestry technology, needs and one's perceptions about methods to acquire these needs. This explains that adoption behavior is dependent upon intervening variables such as individual's needs, knowledge about agroforestry technologies and individual's perception about methods used in meeting these needs in a specific environment.

Needs are regarded as adoption behavior determinants, (Carolin *et al.*, 2018). They are linked with forces that influence a person to act, or that bear or give direction to motion. They motivate adoption behavior and offer it a bearing. Adoption and expansion of agroforestry practices is mainly influenced by the realized returns in meeting individual's needs. In addition, the intervening variables are the best predictors of the adoption behavior and the effect of independent variables is demonstrated in the adoption behavior through the intervening variables. These intervening variables are dependent on socio-economic variables such as, level of awareness, extension contact, income, education and household preferences. Nabanga *et al.*, (2008) explains that farmers are rational beings and make decisions to adopt certain agroforestry systems based on the household and field characteristics such as gender, household size, farm size, fuel wood scarcity and income of the household.

Adoption behavior model, presumes that agroforestry is environmentally practical, economically effective, and generally well-suited in the study area states, (Thangata and Alavalapati, 2003). The theory displays the difference between embracing and development of a new technological practice. Readiness to engage in agroforestry practices could essentially depend on the person's behavior regarding taking risks. On the other hand, furtherance or development of a technology basically hinges on observed benefits of a fresh technology compared to an older technology in reaching essentials. This model is preferred because it clearly shows the distinction between adoption and expansion of technology.

1.13. Conceptual Framework

A conceptual frame work describes the relationship between the independent and dependent variables of the study, (Peter *et al.,* 2013). This study sought to assess the influence of government policies and household characteristics (independent variable) on adoption of Agroforestry practices (dependent variable).

Impact of climate change is shifting seasons that in the long ran affect planning and growing periods of crops and trees. Temperatures rise impact on rainfall leading to increased intensity in evaporation events, shifts in the timing and nature of plant growth and changes in pest and disease dynamics. This was a challenge in the process of adopting selected Agroforestry practices by farmers. Therefore, this study chose climate change as the intervening variable because it is likely to have effects which can interfere with the adoption of selected Agroforestry practices in Kiirua, kibirichia and Ruiri wards, Meru County as shown in Figure 1.1.

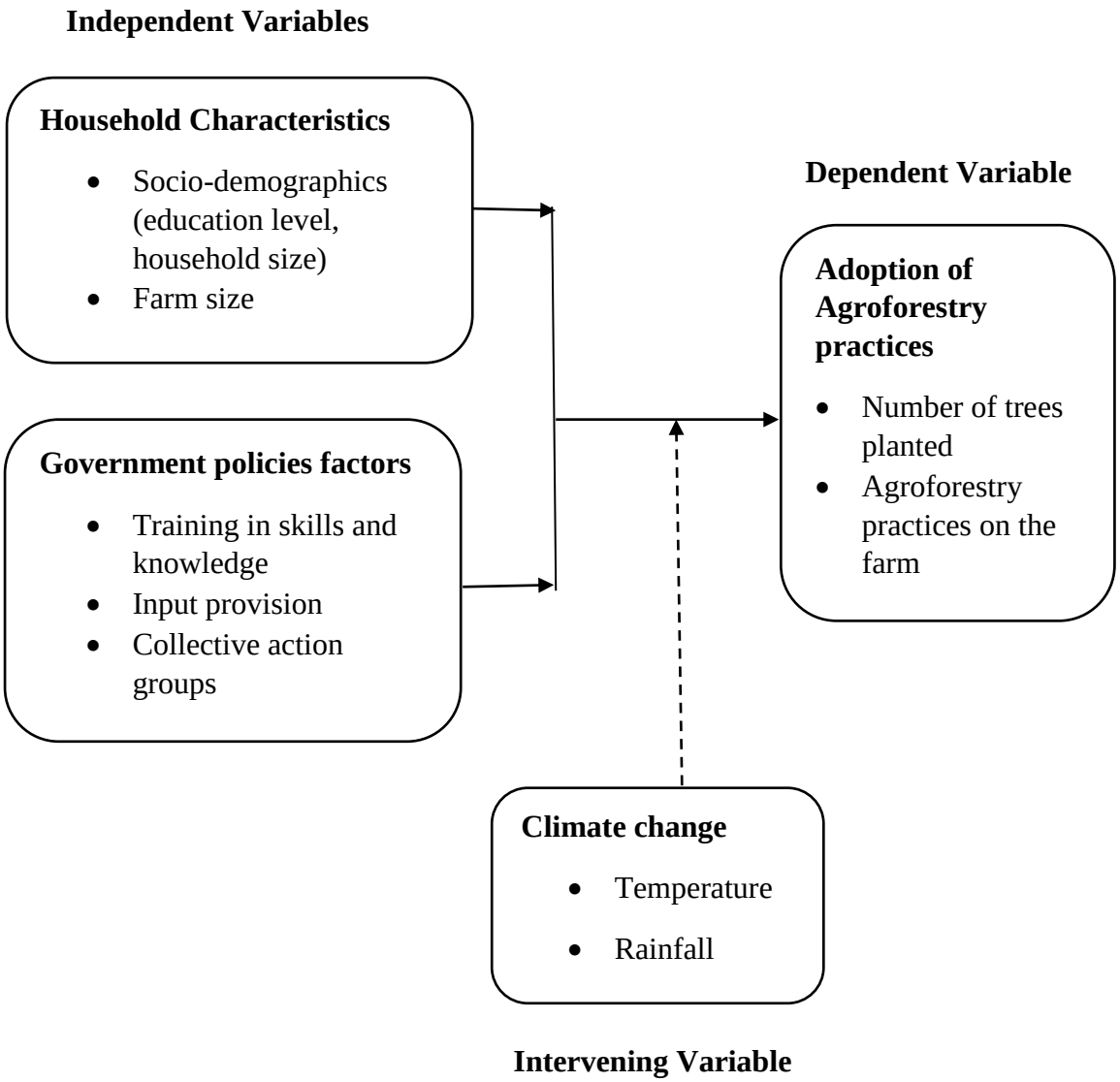

Figure 1.1: Conceptual frame work showing the relationship between Government policies and household factors on adoption of agroforestry practices in Meru county

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter introduces the review of contextual and theoretical literature relating to how government policies and household characteristics influence adoption of agroforestry practices. This study reviewed literature done globally and locally. This chapter contains theoretical orientation, empirical review, conceptual framework and chapter summary.

2.2 Adoption of Agroforestry Practices

Internationally many studies have been done on social economic and adoption of agroforestry practices. Ednam, Hassan and Mawutor (2013) conducted a study on analysis of social economic condition influencing adoption of agroforestry practice in Finland. They observed that household security, labor, incentives, gender, land tenure, farm size and management issues affect adoption of agroforestry practice. They also noted that for there to be a success adoption of agroforestry practice, there should be a genuine interaction between the farmers and agroforestry experts in the entire process of adoption, and the most essential aspect is to involve the locals in the entire agroforestry adoption process.

In their study on social economic evaluation of agroforestry systems in Iran, Bijarpas, Shahraji and Limaei (2015) observed that literacy levels and income significantly affect agroforestry system. They also noted that farmer's participation and multiple farming practice is paramount to farmers since it assists farmers in understanding the system and diversifying their risks thus increasing their revenues. In addition, Maleknia, Beyranvand, Sosani and Adeli (2013) studied on factors affecting

agroforestry acceptance level by farmers in Iran, and noted that knowledge in agroforestry practice and extension programs to farmers are essential for there to be high levels of agroforestry acceptance by farmers.

In Africa several studies have been done on adoption of agroforestry practices. Mulu (2014) examined how social economic factors are associated with adoption of agroforestry practices in Ethiopia. It was noted that many small-scale farmers had adopted agroforestry in Ethiopia but they were still struggling with financing, type of seedlings preferred by households and household income. Ahmed (2014) researched on the use of technology in agroforestry practices and how it enables farmers to adopt new strategies in agroforestry practice. He observed through use of technology small scale farmers are in a position to identify the right seedlings to plant, type of trees to plan, type of furrows and to curb fire outbreaks. He also argues that utilization of technology in adoption of agroforestry will enhance high food production, increase farmer's revenue and promote environmental protection practices. Worku (2016) examined agroforestry and land productivity in Ethiopia, he observed that cash tree and adoption of agroforestry was beneficial to farmers since it improved their income levels and helped them to diversify their farming practices.

In a study on adoption of agroforestry in Malawi, Thangata and Alavalapati (1996) established that farmers modified technologies to suit their situations. They noted that it is important to involve farmers in the entire agroforestry adoption process. Mwase, Sefasi, Njoloma, Nyoka, Manduwa and Nyaika (2015) examined factors affecting agroforestry and evergreen practices in Southern Africa. They observed that social economic and biophysical are the factors affecting adoption of agroforestry practice.

In addition, they also argued that for there to be effective adoption of agroforestry there should be policy formulation, budget allocation to the concerned authorities and farmers training and start up inputs is important for agroforestry adoption process.

In Ghana, Mohammed (2017) conducted a study on agroforestry technology adoption and its effect on farmer's crop productivity. The study established that adoption of agroforestry practice has indeed improved farmers crop productivity, he also argues that extension programs to farmers and provision of seedlings should be provided to farmers.

In East Africa, Mgeni (2008) examined dissemination and adoption of status of agroforestry practices in Tanzania, he noted that agrosilviculture and agrosilvopasture with Taungya mixed intercropping and home gardening have been widely adopted in Tanzania. Woody perennials species, eucalyptus and pines are the type of trees species that have been adopted. He further argues that despite the high degree of agroforestry adoption in Tanzania there is insufficient provision of germplasm, scarcity of land and limited knowledge about dissemination and adoption of agroforestry practices in Mfundi in Tanzania.

In Uganda Kabiru, Hassan, Hadi, Umar, Musab and Bello (2018) examined limiting factors affecting Agroforestry adoption in Uganda. It was observed that agroforestry practices are well known in Uganda, but farmers still shy away in adopting the practice. This has been worsened by low education levels, small farm sizes and lack of income among the house hold. In addition, there was also lack of interaction of agroforestry experts and farmers.

In Kenya Okuthe, Ngesa and Ochola (2013) noted that adoption of agroforestry practices improves food production. Lack of information about the need to adopt agroforestry practices has greatly affected adoption of technologies in Kenya. Makori (2017) analyzed how social economic factors affects agroforestry adoption among small scale farmers, he argues that there needs to be extension services to farmers in agroforestry practices after adoption of the practice. The concerned authorities should also offer other incentives to farmers who adopt the practice as a form of encouragement. In some instances, some traditional beliefs influence acceptance of Agroforestry practices. Oino and Mugure (2013) examined farmer-oriented factors that influence adoption of agroforestry practice in Kenya. They argue that famers will only engage in adoption of agroforestry practice if only the nature and type fit their household desires. Also, they noted that if the households adopt agroforestry, they will increase crop productivity, increased household revenue, soil fertility and environmental conservation.

2.3 Types of Agroforestry Practices

Three types of agroforestry systems practiced in Meru County are discussed, they include Alley farming, Agrisilvicultural, and agrosylvopastoral.

2.3.1 Alley Farming System

According to Elizabeth, Athapol & Teerapol (2010) defines alley as farming system that includes leguminous trees planting in rows with crops grown between them. The grown trees are managed by cutting back at various intervals. The leguminous trees are planted four to five meters apart. According to Sumberg & Okari (2014) alley farming is the production of crops within alleys formed by rows of fast-growing leguminous trees. The trees are pruned and used as mulch and livestock feed.

Nkamleu & Manyong (2005) notes that alley farming includes leguminous trees planted in rows in cropland with spacing between the rows. The grown trees are managed by cutting back at various intervals

In another study Rahaman (2018) examined the effect of alley farming on soil fertility. The objective of the study was to compare soil supplements and harvest yields of sorghum planted under four supplement enhancement routines including root pruned, root flawless alley cropping with Albizia julibrissin, leguminous wither cover cropping with Trifolium incarnatum and in natural compost expansion. The study revealed that alley cropping provided greater nitrogen additions than other treatments.

In a study by Eleanor (2016) examined nutrient addition and crop yields of an alley cropping system in the Piedmont of Georgia. The study revealed that, alley cropping improved on soil fertility and increased crop yields. Hedgerows have also produced some large amounts of biomass high in nutrient content. In addition, hedge rows planted along contour lines have reduced soil erosion a major cause of soil degradation. Wang *et al.,* (2010) affirms that pruning and return of residues from hedgerow trees through alley cropping contributes to recycling of plant nutrients, enhancement of soil structure, soil erosion control and maintenance of high soil nutrients status.

In Africa alley farming was developed as means of maintaining soil fertility in fields under cultivation. In West Africa soils have low organic content, fragile and easily degraded when the vegetation cover is lost. Alley farming improves marginal land and extend tenure for farming. Ochiaka (2013) conducted a study on determinants of

adoption of modern Agroforestry technologies by farmers in Enugu Nigeria. The study revealed the use of alley farming has greatly improved on soil fertility and crop yields.

2.3.2 Agrisilvicultural Farming System

According to Islam *et al.,* (2017) agrisilviculture is a system that is practiced by people residing on the mid mountains or at foothill of mountains. These hilly areas are devoid of vegetation and suffer from scorching heat during summer and lack of moisture. Farmers plant forest trees species around their farms, which serve as boundaries as well as provide much needed fuel and fodder.

A study by Sangeetha, Shanmugan & Usha (2016) examined factors affecting adoption of agroforestry technologies in Tamil, Nadu. The study revealed that farmers were largely aware of agroforestry and had adopted agrisilviculture technology. Additionally, the study noted that information on management of agroforestry system should be communicated in a simpler language for easy understanding and interpretation. David, Bernard & Aringaniza (2017) examined determinants of agroforestry adoption as an adaptation means to drought among smallholder farmers. The study revealed that majority of the farmers had adopted Agrisilviculture. In addition, the study established that agroforestry adoption had potential benefits to famers and they include sufficient food provisions, fodder, and soil erosion control and soil fertility enrichment. Further it was noted that inadequate funds, shortage of tree planting stock, limited extension services and lack of information on agroforestry adoption was a hindrance.

A study by Chija (2013) examined adoption status and management of Agroforestry systems and technology. The study revealed that Agri silviculture had been adopted by farmers in Kasulu, Tanzania. Further, it noted despite the fact that farmers had adopted agrisilviculture there were setbacks in the process which included lack of knowledge, land shortage and lack of capital.

2.3.3 Agrosylvopastoral Farming System

According to Mary (2013) agrosylvopastoral is a system of resources where trees are integrated with other aquatic organisms like fish, snails and other aquatic foods. Ebitario (2007) argues that agrosylvopastoral is a system where trees, forages and livestock are combined and managed as a single integrated practice. Reis *et al*., (2009) notes that agrosylvopastoral system is a type of agroforestry system designed for livestock production which combines leguminous species with wood shrubs and tree species to provide forage and ecological benefit.

On the other hand, Dian, Mark & Adena (2016) examined overcoming history: attitudes of resource professionals and farmers towards silvopasture in Southwest Wisconsin. The study revealed that in spite of the fact that resource professionals were hesitant to support livestock animals' access to forests, they were warily keen on investigating silvopasture as a way to improve management of grazing in the wooded areas and as a management tool for Savanna reclamation

In their study Rosa *et al*., (2016) examined the extent and success of current policy measures to promote agroforestry across Europe. They revealed that silvopasture is the most spread agroforestry practice in Europe. In addition, the study revealed that a

total area of permanent crops, woodland, and shrub with tree cover, grass land with sparse cover and shrub land without tree cover was considered for silvopasture. Mathew & Sarah (2016) in their study, agroforestry the next step in sustainable and resilient agriculture, noted that intentional combination of trees and shrubs with crops or livestock is the next sustainable agriculture. They further argue that by mimicking nature's function, agroforestry has the potential to remain productive while supporting a range of ecosystems.

In Tanzania Mary (2013) conducted a study on adoption status and management of Agroforestry systems and technology by communities, Kasulu District, Kigoma, Tanzania, revealed that agrosylvopastoral adoption by farmers in Kasulu was high. Further she noted that income generation, farmer's awareness and access to extension services were some of the most critical factors that enhanced adoption of agroforestry while lack of knowledge, land shortage and lack of capital were most limiting factors.

2.4. Social Economic Factors and Adoption of Agroforestry Practices

Three household related factors were studied, they included: household preferences to agroforestry, the size of the farm and household characteristics.

2.4.1 Household Preferences to Agroforestry Practices

House hold preferences are a placeholder for the broad category of household-specific influences such as risk tolerance, intra household homogeneity, and conservation attitude. Since preferences arc difficult to measure explicitly, proxies are normally used with socio-demographic variables such as age, gender, and education. The assessment of the literature shows adoption is more likely in a household with higher education level and greater proportion of males. The male effect could reflect the

endowment effect discussed next. By and large, age is an insignificant explainer of adoption.

Mustapha *et al*., (2012) examined how socio-economic factors influence the adoption of improved agricultural technologies, in Nigeria. The study revealed that house hold preferences have an impact on adoption of new agricultural technologies, this mostly was due to house hold preferring to what they usually plant other than what they don't know.

Madalcho and Tefera (2016) conducted a study in Gunugo watershed at Wolayitta zone in Ethiopia, with an objective to assess the socioeconomic factors affecting tree planting in agroforestry practices. The findings revealed a positive correlation between household preferences and agroforestry adoption. Larger households preferred to plant more trees than small households. This was attributed due to availability of labor that enabled the households to provide management. He argues that larger households would prefer to adopt new agroforestry practices than small firm holders who tend to be conservative.

In a study by Waluse *et al*., (2012) establishing the most preferred organic soil management techniques among farmers and the factors influencing the choice of these techniques. It was revealed that a preference by any house hold member may influence the adoption of agroforestry practice. This was further portrayed by other household members in the society who have influence in decision making. More over the highly regarded village elders in the society also impacts on decision making process thus affecting agroforestry adoption. The household preferences positively

influence adoption of labor-demanding agricultural technologies since they have the ability to relax the labor limitations necessary in the course of introduction of new technologies (Obare *et al*., 2009). The studies above failed to clearly articulate how household preferences as a factor influences agroforestry adoption. This study therefore seeks to fill this gap by generating information on the role household preference play in agroforestry adoption practice. This will give a clearer picture of how various persons in the household contribute to adoption and management of agroforestry practices.

2.4.2 Size of Farm owned by the Households

According to Geremew (2016) examined factors influencing agroforestry adoption decisions on the farm households and its effects on farmland productivity. It was observed that farm size has a significant effect on farmland productivity. Additionally, it was noted that if there was surplus farmland, there was increased adoption of Agroforestry Practices.

On the other hand, Kassa, (2015) examined the determinants of fruit tree-based agroforestry system, the study contrasted economic performance vs mono-cropping system, and the findings indicated that the size of the farm is essential when deciding to adopt agroforestry practices. The findings further established that farmers with big farm sizes were eager to adopt agroforestry that those with small parcels of land, farmers with large pieces of land are able to practice mixed farming without interfering with the household food, unlike the small farmers who feared lack of enough food for the family consumption.

In Kenya Makori (2017) conducted a study on the analysis of social economic factors and their effect on adoption among small scale farmers in Temeyyota in Nakuru County. Findings from the study established that farm size has an impact on adoption of agroforestry practices. The study further revealed that when the size of the farm reduces the agroforestry adoption also reduces or decreases.

In Uganda Kabiru (2018) carried out a study on limiting factors affecting agroforestry adoption. It was revealed that owners with larger farm size are more likely to adopt agroforestry practices, this is because the owners will set aside a piece of land for the fodder trees on the other hand small farm owners will not agree to occupy large area of their farm with trees instead, they will prefer food crops. In addition, the study revealed that large farm sizes facilitate easy tree and crop diversification.

According to Maluki *et al*., (2016) carried out a survey targeting smallholder households in the semi-arid Makueni County, Kenya. The objective of the survey was to ascertain the various agroforestry practices adopted and the extent of adoption. The study revealed that the bigger the size of the farm the more the likelihood of the farmers to adopt agroforestry practice. The study further revealed that soil adoption of agroforestry will improve soil fertility through intercropping trees with crops.

2.4.3 Household Characteristics Influencing Agroforestry Practices

Another study conducted on agricultural technologies adoption suggests that, household characteristics such as gender, farmer's age, level of education and family size influences adoption rate of new techniques among farmers (Ayinde *et al.*, 2010). Their study revealed that gender, education level of farmer, farming experience, access to extension agents and access to credit have significant and positive influence

on adoption. According to a study, Ajayi *et al*., (2003) age emphatically affected choice to take part in agricultural activities including agroforestry practices. Young farmers are more dynamic and energetic to work than more established farmers. This makes them stand the opportunity of embracing technology particularly those that are labor intensive. According to Muneer (2008), age of the farmer, gender, education level, social participation of the farmer and area owned were the factors that had greater influence on the adoption of agroforestry practices in Northern Kordofan Sudan.

In a study by Nkamleu and Manyong (2005) revealed that the gender of a farmer, household family size, level of education, famers experience, membership within farmers associations, contact with research and extension agents, security of land tenure, agro-ecological zone all facilitated the adoption of Agroforestry systems in Cameroon.

Various studies have concluded that educated farmers have higher level of adoption of agricultural technologies the uneducated ones. According to Ainembabazi and Mugida (2014) education has a higher bearing on adoption of technology in the sense that educated farmers have more capacity to decode information in print and electronic forms due to their literacy power than their counterparts. A study by Irshad *et al.,* (2011) indicated that education has high influence on adoption of Agroforestry. They further argue that famers with high understanding of tree cultivation were ready to adopt agroforestry. Ghulam *et al.,* (2011) further affirm educated households were less conservative and were ready to embrace innovative ways in their farms.

Agroforestry being a labour intensive venture, larger family size present higher likelihood for adoption (Kebebe *et al.,* 1990). A study by Orisakere and Agomuo (2011) showed that farmer's household size has positive relation to the adoption of agroforestry technologies.

In a study by Alavalapati *et al*., (2008), in Bahia, Brazil showed that income is essential for agroforestry adoption to work. Further the study revealed that high income earners are able to purchase the required seedlings and afford labor unlike low income earners who may prefer not to adopt agroforestry practices. According to Munyaradzi and Torquebiau (2010) in their investigation with the objective to assess agroforestry adoption by smallholder farmers in Gutu District, Zimbabwe, documents that; the ability or inability to meet the cost of pesticides, seeds and other inputs necessary for practicing new agroforestry technologies relies on household income.

2.4.4 Training in Agroforestry Practices

According to Smith (2010), primary obstacle to selection of agroforestry was the inadequate awareness among farmers and landowners of Agroforestry practices in Hamstead Marshall. For agroforestry to be embraced on a more extensive scale, economic viability and practical management skills should be shown to farmers and landowners. Bringing issues to light of the capability of agroforestry is basic for advancing Agroforestry as a standard land use framework. Thangata and Alavalapati (2003) confirmed that household dimension of awareness about agroforestry practices relied upon contact with extension agents, neighbors and participation in field days.

The success of agroforestry can be attributed to support from government institutions. Chitakira and Torquebiau (2010) identified research, extension and technical and

material support as major benefits farmers receive from external agencies. Chitakira and Torquebiau (2010) distinguished research, expansion and specialized and material help as major benefits farmers get from external associations. Extension interaction play a great role in adoption of agroforestry practices. It is through extension services where farmers are trained and furnished with data on agroforestry practices. As indicated by Keil et al., (2005) farmers who benefited by different extension services in type of farm experiments of agroforestry technologies were probably going to embrace agroforestry adoption than the individuals who did not benefit.

Adoption of agricultural technologies by farmers is to a great extent affected by sensitization, mentoring and exhibitions by extension agents (Lawal and Oluloye, 2008). A study by Abol and Akpabbio (2008) demonstrates that if there is powerful linkage among farmers and extension agents, farmers will be privy to information and have access to inputs that will enable them in adopting technologies, for example, agroforestry for climate change adaption**.**

2.5 Summary Research Gap

The summary presented in Table 1.1 shows a review of literature, which has shown among others, how social economic factors influence adoption of agroforestry practice in other places. These discuses most studies carried out in Europe, Asia and Africa on adoption of agroforestry practice. Various social economic variables are illustrated and how they influence adoption of agroforestry. The review of related literature also serves as a guide towards the methodology, reporting and results. It also serves as a guide towards the methodology, reporting and results. It also contains research gap from other scholars that explain the research gap or phenomena.

Table 1.1 Summary of the Review of Literature

Author	Title	Findings
Habib Wallace Mugeni (2008)	Dissemination and adoption status of agroforestry research practices in Mfundi District, Iringa Region, Tanzania.	The study established that 65% have adopted agroforestry practice. Further the study revealed although many people have adopted agroforestry, they were affected by land scarcity, insufficient germplasm and limited knowledge. The findings did not elaborate more on the research gap. This study intends to elaborate more on how farm size, insufficient seedlings and farm size influence adoption of agroforestry.
Jamala, G, E, Shehu, J, Yidu and L., Joel (2014)	Factors affecting adoption of Agroforestry among small holder farmers in Taungo, Southeastern, Adamawa State, Nigeria.	The study established that lack of knowledge, lack of seedling, lack of awareness and lack of information, affected adoption of agroforestry practices. This study will seek to elaborate more on how lack of seedlings, knowledge and lack of awareness influences adoption of agroforestry
Nyamweya Joseph Makori (2017)	Analysis of social economic factors affecting agroforestry adoption among small scale farmers holders in Temeiyotta location in Nakuru County	The study established that house hold level of education, size of the farm and house hold income as factors affecting on adoption of agroforestry practice. This study did not clearly state how social economic factors influences adoption of agroforestry practice.
Kabiru, Hassan, Hadi, Umar, Musab and Bello (2018)	Limiting factors affecting agroforestry adoption in Butta sub county, Manafwa District Uganda	The study established that illiteracy, shortage of land, income and lack of extension to farmers hindered agroforestry adoption. This study will discuss the number of farmers and elaborate further on how income and size of the farm, how they influence adoption of agroforestry practice.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter mainly describes and focuses on the research design, target population, sampling procedures, sampling size, and data collection methods and data analysis. The chapter also highlights the ethical principles and the general framework that the study employed to achieve the objectives.

3.2 Research Design

The study adopted a descriptive research design. Cooper and Schindler (2003) defined a descriptive research as a process of collecting data in order to test hypotheses or to answer questions concerning the current status of the subjects in study. It involves formulating the objectives of the study, designing the methods of data collection, selecting the sample, data collection and analyzing the results. Mugenda & Mugenda (2003) state that a cross sectional descriptive research design provides an in-depth account of events, relationships, experience or processes accruing in that particular instance.

3.3 Research Site

The study was carried out in Ruiri/ Rwarera, Kiirua/Naari and Kibirichia wards located in Buuri Sub County Meru County. The wards have a total population of 41,470, Pulling Apart or Pooling Together (KBS 2013). The wards have distribution of rainfall ranging from 300mm per annum. There are two seasons with the long rains occurring from mid-March to May and short rains from October to December. Temperatures ranges from 8^0 C to 32 ^{0} C during cold and hot seasons respectively. Households in these wards practice farming where Wheat and horticulture farming are

dominant. Ruiri/ Rwarera, Kiirua/Naari and Kibirichia wards practice both small scale farming and large-scale farming.

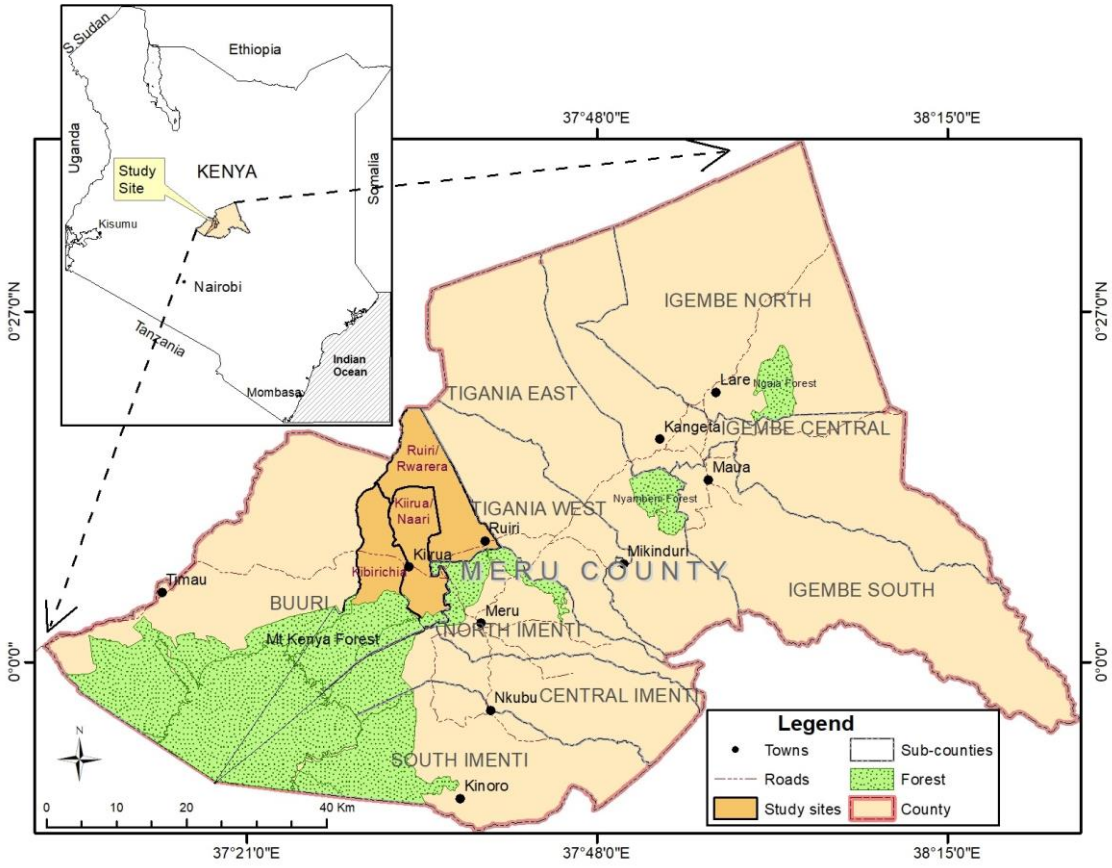

Figure 3.1: Location Area of study map

3.4 Target Population

The study targeted 895 households in Kiirua, kibirichia and Ruiri wards, located in Buuri sub-county, Meru County. The three wards (Kiirua, kibirichia and Ruiri) have a total population of 41,470 people.as shown in Table 3.1.

Table 3.1: Target Population in Buuri Sub-county

Ward Name	Family Agriculture holding %	Family Agriculture holding	Total population
Ruiri/Rwarera	50.1	209	10,482
Kibirichia	41.9	350	14,649
Kiirua/Naari	48.6	336	16,339
Total		**895**	**41,470**

Source: KNBS (2013)

3.5 Study Sample

This section describes the sampling technique and sampling size that was used to select the sample size used in the study.

3.5.1 Sampling Size

The study sample for the 895 households was 268. The sample was determined based on the formula of Kjercie and Morgan (1970) which is the same as using the Krejcie and Morgan's sample size determination table. The sample size determination table is derived from the sample size calculation using the formula below (Krejcie & Morgan, 1970).

$$s=X^2\ NP(1-P) \div d^2\ (N-1) +X^2\ P(1—P)$$

Where,

s= required sample size.
X^2= the table value of chi-square for 1 degree of freedom at the desired confidence level (0.05 = 3.841).
N = the population size.
P= the population proportion (assumed to be 0.50 since this would provide the maximum sample size.)
d= the degree of accuracy expressed as proportion (0.05).

Table 3.2: Krejcie and Morgan's Sample Size Determination Table

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Where,
N= Population Size
S= Sample Size
The 268 samples were proportionally allocated to the three wards of Buuri sub-county covered in this study as shown in Table 3.3.

Table 3.3: Proportional Allocation of the Samples to the Three Wards

Ward Name	**Households**		**Sample Size**
Ruiri/Rwarera	209	269/895*268	63
Kibirichia	350	350/895*268	105
Kiirua/Naari	336	336/895*268	101
Total	**895**		**268**

3.5.2 Sampling Procedure

Sampling is a technique of choosing a sub-group from a population to participate in the study; it is the process of selecting a number of individuals for a study in such a way that the individuals selected represent the large group from which they were selected (Ogula, 2005).

A stratified random sampling technique was employed to select 268 respondents. The area was divided into the three wards, which formed the strata. In each strata a sampling frame was created based on the Chiefs list of households in the area. Using the sampling frames, the respondents were selected at random for the survey. The Chief and the "*Nyumba kumi"* initiative assisted in identifying the selected farmers.

3.6 Data Collection

This section discusses methods employed in data collection and the types of data collected.

3.6.1 Data Collection Instruments

The primary data was collected using a structured questionnaires for the farmer's respondents and interview guides/checklist for Key Informants. The structured questionnaire consisted of questions that were related to the objectives of the study. The questionnaire was administered by the researcher. The researcher was also able to observe adoption of agroforestry practices in the area under study with an aim of comparing the farmers' responses from the filled questionnaires.

Secondary data was gathered by the researcher gathered through reviewing relative literature from books, journals, working papers and internet sources. Information was

also retrieved from environmental and agricultural ministries within Meru County government.

3.6.2 Pilot Testing of Research Instruments

A pre-test study was carried out in in the neighbouring ward to the study area in order to make sure the instruments are reliable. It was done to assess the capability of the research instruments to collect the required data for the study. Additionally, it showed the flow of information and ease of the respondents to answer all the questions in the semi structured questionnaires and make corrections where necessary before mass production of the questionnaires. In this study 27 (10% of the sample size) respondents were involved in the pilot study selected and were not be included in the sample chosen for the study, Mugenda & Mugenda (2003).

3.6.3 Instrument Reliability

The Cronbach's alpha was used to test the reliability of the instrument. This involved administering the same instruments away from the study area to a group of subjects with similar characteristics as the study area. A Cronbach's alpha of 0.07 and above was accepted as reliable (Gable & Wolf, 2013).

3.6.4 Instrument Validity

The researcher together with the two supervisors and the examiners within the School of Science and Technology at Africa Nazarene University checked the instruments for content validity. Validity connotes how accurately a test measure measures what it intends to measure Kothari (2004). The validity of the research questions was ascertained in consultations with the supervisors whose comments and or suggestions were incorporated in the instrument to increase validity.

3.6.5 Data collection Procedures

The researcher obtained a research permit from NACOSTI and from the County agricultural offices. The Chief and *Nyumba kumi* were alerted and assisted the researcher to identify the selected farmers. Permission was then sought from the famers to collect the data, after which the farmers participated in answering the questions. The researcher used a structured questionnaire to collect the required data from the respondents, (Kothari, 2004).

3.7 Data Analysis

After collecting data, the researcher coded the filled questionnaires and entered them for analysis using the Statistical Package for Social Sciences, denoted as (IBM SPSS version 26). After entering the data, the generated data was analyzed using descriptive and inferential statistics. In descriptive statistics such as a measure of central tendency and measure of dispersion were presented in form of frequency distribution tables and figures. Inferential statistics was presented in form of table of figures. In addition, the study used the Chi-square to test for variable association between the dependent and independent variables:

3.8 Legal and Ethical Consideration

To guarantee that the study met ethical standards, the researcher obtained informed consent from participants and ensured that all participated voluntarily. The participants were allowed to pull out of the study at any time without prior notice to the researcher. The respondents were not required to indicate their names on the questionnaire to ensure anonymity.

Table 3.4: Summary of Data Analysis and Statistical Tools

Objectives	Variables	Method of Data analysis
(i) Assess how household characteristics influence adoption of Agroforestry practices in Buuri sub-county, Meru County.	Household characteristics and adoption of Agroforestry practices	Descriptive and inferential statistics
(ii) Establish how farm size influence adoption of Agroforestry practices in Buuri sub-county, Meru County	Farm size and adoption of Agroforestry practices	Descriptive and inferential statistics
(iii) Assess how farmers' training influence adoption of Agroforestry practices in Buuri sub-county, Meru County	Farmers' training and adoption of Agroforestry practices	Descriptive and inferential statistics
(iv) Establish how input provision influence adoption of Agroforestry practices in Buuri sub-county, Meru County	Input provision and adoption of Agroforestry	Descriptive and inferential statistics
(v) Determine how collective groups action influence adoption of Agroforestry practices in Buuri sub-county, Meru County	Collective action groups and adoption of Agroforestry practices	Descriptive and inferential statistics

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter provides an in-depth analysis of the data and presentation of research findings to achieve the objectives of this study, which was to assess the influence of government policies and household characteristics on adoption of agroforestry practices in Kiirua/Naari, Kibirichia and Ruiri/Rwarera, wards in Meru County. The chapter has the following sub-topics: response rate, characteristics of the households, farmers preferences, adoption of Agroforestry practices by farmers, influence of household characteristics on the adoption of Agroforestry practices, influence of farm size on adoption of Agroforestry practices, influence of farmers training on the adoption of Agroforestry practices, influence of input provision on adoption of Agroforestry practices and the Influence of collective action on the adoption of Agroforestry practices.

4.2 Response Rate

The study had a 100 % response rate. The total sample of 268 farmers responded to the questionnaire. The households where the farmers were not available they were replaced by the researcher with other households in the study area selected at random. Therefore, the data analysis was based on 268 respondents who represented (100 %) respondent rate. According to Mugenda and Mugenda (2003), a sample response rate of (60%) and above is recommendable for generalizing the findings of the study. In this case, the study response rate was (100 %), thus fulfilling the requirement of the study. The response rate was calculated by the wards covered by the study and the results are presented in Table .4.1.

Table 4.1: Response Rate by Study Wards in Buuri Sub-county

Ward Name	Households	Sample Size	Percent
Ruiri/Rwarera	209	63	23
Kibirichia	350	105	39
Kiirua/Naari	336	101	38
Total	**895**	**268**	**100**

The distribution of the sampled respondents by ward in Buuri sub-county is presented in Table 4.1. Out of the total number sampled, (39 %) of the respondents were from Kibirichia Ward, (38 %) from Kiirua/Naari ward and (23%) from Ruiri/Rwarera.

4.3 Household Characteristics in Buuri Sub-County

Information on the respondents' household characteristics were collected during the household survey. Data on the sex of the household heads, age of the household heads, sources of the household income, land tenure system and the tree preferences of the farmers.

4.3.1 Sex of the Household Head

The sex of the respondents was noted during the survey and the information was analysed and the frequency distribution of the data is shown in Table 4.2.

Table 4.2: Sex of the Household Head

Sex	Frequency	Percent
Male	246	91.7
Female	22	8.3
Total	268	100

The majority (91.7 %) of the households were led by men, while the remaining 8.3 % were led by females.

4.3.2 Age of the Household Head

The household heads were asked to state their age. This information was then analysed and the frequency distributions are given in Table 4.3.

Table 4.3: Descriptive Statistics and Frequency Distribution of the Age of the Respondents

Age Categories	Frequency	Percent
20 30	42	15.7
31-40	104	38.8
41-50	69	25.7
51-60	31	11.6
Above 61	22	8.2
Total	268	100

The majority (54.5 %) of the respondents were below 40 years, while 8.2 % were above 60 years. The 31to 40 years age category was the highest (38.8 %), while the age category of above 61 years was the lowest (8 %).

4.3.3 Sources of Household Income

The household heads were asked to state their main sources of income. Their responses were recorded and analysed. There existed three (3) main sources of income as shown in Table 4.4.

Table 4.4: Main Sources of Household Income

	Frequency	Percent
Farming	174	64.9
Formal employment	30	11.2
Informal employment	64	23.9
Total	268	100.0

The majority (64.9 %) of the respondents relied on farming for their livelihood, followed by informal employment (23.9 %) and finally formal employment (11.2 %). The informal employment included activities such as business and transportation. Formal employment referred to working for a monthly salary in government and non-governmental organization as teachers, clerks and cashiers.

4.3.4 Type of Land Tenure System

The farmers were asked to state the type of land ownership they practiced. The data was then analysed and the results of the frequency distribution are presented in Table 4.5.

Table 4.5: Type of Land Tenure System in the Study Area

Type of tenure	Frequency	Percent
Owned with title	147	54.8
Owned without title	68	25.4
Renting	39	14.5
Government scheme	14	5.3
Total	268	100

Four types of land ownerships were found in the study area as shown in Table 4.5. The household heads with title deeds for their farms were the majority (54.8 %), and the ones without a title were 25.4 %, while 14.5 % were renting their land and 5.3 % were living on government schemes.

4.4 Farmers AgroforestryTree Species Preference

The preference of farmers for the different Agroforestry tree species was determined by asking the farmers to state the Agroforestry tree species they preferred to have on their farms. The data was analysed and the frequency distribution for the different tree species is presented in a multiple response Table 4.6.

Table 4.6: Tree Species and their Preference by Famers in Buuri Sub-county

Common Name	Botanical Name	Frequency	Percent
Grevilia	*Grevillea robusta*	259	97
Croton	*Croton megalocarpus*	201	75
Combretum	*Combretum molle*	153	57
Miraa	*Catha edulis*	123	46
Cypress	*Cupressus lusitanica*	118	44
Cordia	*Cordia africana*	96	36
Cedar	*Juniperus procera*	92	34
Eucalyptus	*Eucalyptus saligna*	88	33
Meru oak	*Vitex keniensis*	76	28
Casuarina	*Casuarina equisetifolia*	67	25
Black wattle	*Acacia mearnsii*	66	25
Pine	*Pinus patula,*	54	27
Calliandra	*Calliandra calothyrsus*	38	14
Fruit Trees			
Avocado	*Persea americana*	198	74
Mango	*Mangifera indica*	178	66
Macadamia	*Macadamia tetraphylla*	36	13

n=268

The farmers in Buuri sub-county identified seventeen (17) trees listed in Table 4.6 as the preferred species and which they planted on their farms. The trees were planted for their food especially the fruit trees, agroforestry, timber and energy values. The highly preferred tree species was *Grevillea robust*a (97 %), followed by *Croton megalocarpus* (75 %), then *Persea americana* (74 %), *Mangifera indica* (66 %), *Combretum molle* (57 %), *Catha edulis* (46 %), *Cupressus lusitanica* 44 %, *Cordia africana* 36 %, and *Juniperus procera* 34 %.

4.5 Adoption of Agroforestry Practices by Farmers in Buuri Sub-county

The dependent variable for this study was Adoption of Agroforestry practices b farmers in Kiirua, Kibirichia and Ruiri wards. The variable was operationalized as an index that involved three indicators, as follows: (i) number of trees planted by the farmer on his farm, (ii) Number of different tree species planted by the farmer on his farm, and (iii) the number of Agroforestry practices the farmer has implemented on his farm.

The farmer was asked to state the number of trees he had planted on his farm that had survived, this figure was added to the number of tree species the farmer had on his farm. The farmer was then asked to state all the Agroforestry practices he maintained on his farm. The Agroforestry practices practiced by the farmers were twelve (12), they included: alley farming, Taungya or PELIS, agrosylvopastoral, home gardens, woodlot, orchards, boundary fencing with live fence, perennial grasses on terraces, tree planting in rows, and grass pastures. The Agroforestry practices were measured using a 0, 1 variable or a dummy variable.

The values of the indices of each households were summed together to form the index of farmers adoption of Agroforestry practices in the study area. The index was grouped into six categories to describe the level of adoption of Agroforestry practices, as follows: Very high, High, Moderate, Low and Very low levels. The descriptive statistics and the frequency distribution of the index is given in Table 4.7.

Table 4.7: Level of farmers Adoption of Agroforestry Practices

Categories	Level	Frequency	Percent
0-0.99 (	Very Low	9	3.4
1-1.99	Low	105	39.2
2-2.99	Moderate	78	29.1
3-3.99	High	38	14.2
4-5	Very High	38	14.2
Total		268	100.0

Mean 2.48±.067, median 2.14, mode 1.90, std. dev. 1.09, minimum 0.57, maximum 5

The average level of farmers adoption of Agroforestry practices was 2.48 (SD 1.90) on a scale of 0 to 5, 0 being very low and 5 very high. A large proportion (39.2 %) of the farmers were in the low category (1-1.99). A chi-square test was performed on the data to test the equality of the adoption categories and the results are shown in Table 4.8.

Table 4.8: Chi-square Test for the Equality of Categories for the Level of Adoption of Agroforestry Practices by Farmers in Buuri Sub-county

Categories	Observed N	Expected N	Residual	Chi-square
Very Low	9	53.6	-44.6	χ=105.59
Low	105	53.6	51.4	*df*=4
Moderate	78	53.6	24.4	*p*=0.001
High	38	53.6	-15.6	
Very High	38	53.6	-15.6	
Total	268			

The chi-square test indicates that the majority of the households in Buuri sub-county had a level of Agroforestry adoption of between 1 and 1.99 (Low level) on a scale of 1 to 5. This result was found to be statistically significant (χ^2 105.59, *df* 4, *p*<0. 001). This level of adoption can be described as low level of adoption.

4.6 Influence of Household Characteristics on the Adoption of Agroforestry Practices by farmers in Buuri Sub-county

The first objective of this study was to assess how household characteristics influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya.

4.6.1 Level of Formal Education Attained by the Farmers

The level of formal education was operationalized as the number of years the farmer had attended formal type of education. The farmers were asked to state the highest level they attained in their formal schooling. This was equated to the number years based on the five levels of formal schooling recognized in the study area. The information was analysed and the frequency distribution is presented in Table 4.9.

Table 4.9 Level of Formal Education Attained by the Farmers

Level of Formal Education	Frequency	Percent
Illiterate	4	1.5
Primary	156	58.2
Secondary	78	29.1
College	20	7.5
University	10	3.7
Total	268	100.0

The majority (58.2 %) had attained the primary level of formal education, this translated to 8 years of learning in the four level system. The illiteracy level was very low (1.5 %), while 29.1 % had attained the secondary level and 7.5 % the college level.

4.6.2 Household Number

The second independent variable household number was operationalized as the number of people living in the household, the number included all the young and the adults regardless of their sex. The household heads were asked to state the number of people living in their home. The data was then analysed and the frequency distribution is given in Table 4.10.

Table 4.10: Number of People Living in the Households

Household Number	Frequency	Percent
1-5	145	54.1
6-10	92	34.3
11-15	21	7.9
16-20	10	3.7
Total	268	100.0

The majority (54.1 %) of the households had between 1 and 5 people, while 34.3 % had between 6 and 10 people. Some few households (3.7 %) had up to 20 people living in the household, these were mainly polygamous families with more than one mother.

4.6.3 Analysis of the Influence of Household Characteristic on the Adoption of Agroforestry Practices

The research question number one of this study was stated as:

> How do household characteristics (education level and household number) influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya;

The question was answered by the use of multiple linear regression, where the formal education level and household number formed the independent variable and the level

of adoption of Agroforestry practices formed the dependent variable. The results of the regression model are shown in Table 4.11.

Table 4.11: Regression Model Summary for Household Characteristics and Level of Adoption of Agroforestry Practices

R	R Square	Adjusted R Square	Std. Error of the Estimate
.024[a]	.001	-.007	1.10243

a. Predictors: (Constant), Education level, Household size

The model indicates an adjusted R^2 value of -0.007, meaning that the independent variables farmer's level of formal education and household number explained approximately 0.7 % of the variation in the dependent variable level of farmers' adoption of Agroforestry practices. The F test for the regression model is shown in the ANOVA Table 4.12.

Table 4.12: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	Sig.
Regression	.184	2	.092	0.076	.927[b]
Residual	319.636	263	1.215		
Total	319.821	265			

a. Dependent Variable: Agroforestry
b. Predictors: (Constant), Education level, Household size

The overall regression equation was found to be non-significant (F (1,263) = 0.076, p = .927). The regression coefficients of the model showing the beta, t, and the tolerance levels is shown in Table 4.13.

Table 4.13: Regression Coefficients for Household Characteristics and Level of Farmers' Adoption of Agroforestry Practices

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	p.	VIF
(Constant)	2.481	.162		15.340	.001	
Household size	-.016	.046	-.021	-.341	.733	
Education level	.013	.076	.011	.177	.859	1.000

The regression analysis shows that farmer's formal education level and household number had no statistical significant influence on the level of farmers' adoption of agroforestry practices in Buuri sub-county. Level of formal education had a no statistical significant influence (β= 0.011, t = 0.177, p= 0859), also household number had a no statistical significant influence (β= -0.021, t = -0.341, p= 0733). It can therefore be concluded that farmers' level of education and household number had no statistical significant influence on the adoption of Agroforestry practices by farmers in Buuri sub-county.

4.7 Influence of Land Size on the Level of Farmers' Adoption of Agroforestry Practices

The second objective of this study was to establish how farm size influences the adoption of Agroforestry practices by farmers in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya;

4.7.1 Land Size Owned by Farmers in Buuri Sub-county

The independent variable Land size was operationalized as the size of land that was owned and cultivated by the farmers. The farmers were asked to state the size of land they owned and the descriptive and frequency distribution of the data are shown on Table 4.14.

Table 4.14: Descriptive Statistics and Frequency Distribution of Land Size Owned by Farmers

Land Size in Hectares	Frequency	Percent
.50	12	4.5
.85	1	0.4
.99	1	0.4
1.00	110	41.0
1.10	2	0.7
1.50	7	2.6
1.60	4	1.5
2.00	70	26.1
2.20	1	0.4
3.00	55	20.5
3.50	1	0.4
4.00	4	1.5
Total	268	100.0

Mean 1.7±0.052, median 1.60, mode 1, Std. Dev. 0.859, minimum 0.5, maximum 4

The mean land size owned by farmers in Buuri sub-county was found to be 1.7 (SD 0.859). The minimum land size was 0.50 ha and the maximum land size was 4 ha. The farmers with 1 ha of land were found to be 41 %, while farmers with 2 ha of land were 26 % and those with 3 ha of land were 21 %.

4.7.2 Analysis of the Influence of Land Size to the Adoption of Agroforestry

The second research question was stated as: how does the size of land owned by farmers influence the farmers' level of adoption of Agroforestry practices in Buuri sub-county?

The relationship between the independent and dependent variable was analysed using the bivariate linear regression. The independent variable size of land owned by the farmers and the dependent variable was the level of farmers' adoption of Agroforestry practices. The results of the regression model are shown in Table 4.15.

Table 4.15: Regression Model Summary for Farmers land Size and Famers Adoption of Agroforestry Practices

R	R Square	Adjusted R Square	Std. Error of the Estimate
.365[a]	.133	.130	1.02319

The model indicates an adjusted R^2 value of ($R^2_{adj.}$ 0.130), meaning that the independent variable farmer's land size explained approximately 13 % of the variation in the dependent variable Farmers adoption of Agroforestry practices. The F test for the regression model is shown in the ANOVA Table 4.16.

Table 4.16: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	p
Regression	42.770	1	42.770	40.853	.001
Residual	278.480	266	1.047		
Total	321.250	267			

The overall regression equation was found to be significant (F (1,266) = 40.853, p < .001). The regression coefficients of the model showing the beta, t, and the tolerance levels is shown in Table 4.17.

Table 4.17: Regression Coefficients for Land size and farmer Level of Adoption of Agroforestry Practices

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	p.	VIF
(Constant)	1.676	.141		11.909	0.001	
Farm size	.466	.073	.365	6.392	0.001	1.000

The regression analysis shows that land size has a positive significant influence (β = 0.365, t = 6.392, p <0.001) on the level of farmers adoption of agroforestry practices. It can therefore be concluded that as the land size owned by the farmers increases it

influences the level of adoption of Agroforestry practices by farmers to increase significantly.

4.8 Influence of Farmers' Training on the Adoption of Agroforestry Practices

The third objective of the study was to determine the influence of farmers training on the adoption of Agroforestry practices in Kiirua/Naari, Kibirichia and Ruiri/Rwarera, wards in Meru County.

4.8.1 Farmers Training in Agroforestry

The independent variable farmers training was operationalized as an index that combined four indicators as follows: number of Agroforestry demonstrations attended, number of farm visits attended, number of formal training in agroforestry undertaken at the agroforestry centre, number of extension officers visits to the farm on agroforestry issues. The responses were scored and the scores were summed up to give the index of farmers training in Agroforestry. The descriptive statistics and the frequency distribution of the index are given in Table 4.18.

Table 4.18: Descriptive Statistics and Frequency Distribution for the Index of Farmers Agroforestry Training

Level of Agroforestry Training	Frequency	Percent
1.00	19	7.1
2.00	34	12.7
3.00	62	23.1
4.00	39	14.6
5.00	22	8.2
6.00	22	8.2
7.00	16	6.0
8.00	11	4.1
9.00	11	4.1
10.00	11	4.1
Above 11.00	21	7.8
Total	268	100.0

Mean 4.94±0.18, median 4, mode 3, Std. dev. 3.05, minimum 1, maximum 14

4.8.2 Analysis of the Influence of Farmers Training on the Adoption of Agroforestry Practices

The third research question was stated as: how does Training of Farmers influence the level of farmers' adoption of Agroforestry practices in Buuri sub-county?

The relationship between the independent and dependent variable was analysed using the bivariate linear regression. The independent variable farmers' level of training and the dependent variable was the level of farmers' adoption of Agroforestry practices. The results of the regression model are shown in Table 4.19.

Table 4.19: Regression Model Summary for Farmers Training and the Adoption of Agroforestry Practices

R	R Square	Adjusted R Square	Std. Error of the Estimate
.982[a]	.965	.965	.20610

The model indicates an adjusted R^2 value of ($R^2_{adj.}$ 0.965), meaning that the independent variable farmer's training explained approximately 96.5 % of the variation in the dependent variable farmers adoption of Agroforestry practices. The F test for the regression model is shown in the ANOVA Table 4.20.

Table 4.20: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	p
Regression	309.952	1	309.952	7297.130	.001[b]
Residual	11.299	266	.042		
Total	321.250	267			

a. Dependent Variable: Agroforestry
b. Predictors: (Constant), famers training

The overall regression equation was found to be significant (F (1,266) = 7297.13, p < 0.001). The regression coefficients of the model showing the beta, t, and the tolerance levels is shown in Table 4.21.

Table 4.21: Regression Coefficients for Farmers Training and Adoption of Agroforestry Practices by Farmers in Buuri Sub-county

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	p	VIF
(Constant)	0.739	0.024		30.805	0.001	
Farmer training	0.352	0.004	0.982	85.423	0.001	1.000

The regression analysis shows that farmer's training has a positive significant influence (β = .982, t = 85.42, p <.001) on the farmers level of adoption. It can therefore be concluded that as the farmers training in Agroforestry increase. It enhances the famers' adoption of Agroforestry practices significantly.

4.9 Influence of the Provision of Inputs and Adoption of Agroforestry Practices

The fourth objective of this study was to establish how input provision influence adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya.

4.9.1 Provision of Inputs to Farmers for Agroforestry Practices

The independent variable input provision was operationalized as an index that combined the provision of seeds, provision of seedling and the provision of farm implements by the government and other non-governmental organizations. The index was created by asking the household heads to state whether they had received any inputs and the responses were converted into 0, 1 \(dummy variable). The index was

then created by summing up the 3 inputs. The descriptive statistics and the frequency distribution of the index is shown in Table 4.22.

Table 4.22: Index of Input Provision to Households

Level of input Provision	Frequency	Percent
0.00	11	4.1
1.00	126	47.0
2.00	65	24.3
3.00	66	24.6
Total	268	100.0

Mean 1.69±.054, median 1, mode 1, Std. dev 0.888, minimum 0, and maximum 3

The mean of input provision was 1.69 (SD 0.888). The index ranged from 0 to 3, where 0 indicated households that had not received any inputs and 3 were the households that had received the maximum inputs. The majority (95.9 %) of the households had received at least one input, while 4.1 % had not received any input. The chi-square test was used to test the equality of the index of input provision categories and the results are presented in Table 4.23.

Table 4.23: Chi-square Test for Equality of the Categories of the Index of Input Provision in Buuri Sub-county

Scores	**Observed N**	**Expected N**	**Residual**	**Statistics**
.00	11	67.0	-56.0	χ^2 =98.836
1.00	126	67.0	59.0	*df*=3
2.00	65	67.0	-2.0	*p*=0.001
3.00	66	67.0	-1.0	
Total	268			

The chi-square test indicates that the majority of the households in Buuri sub-county had an index of input provision of 1. These results were found to be statistically significant (χ^2 =98.836, *df* 3, *p*< 0.001).

4.9.2 Analysis of the Influence of Input Provision on Farmers' Adoption of Agroforestry Practices in Buuri Sub-county

The fourth question of this study was stated as: How does input provision to farmers influence the influence the adoption of Agroforestry practices by farmers in Buuri sub-county. The relationship was determined using simple linear regression, where the index of input provision to farmers was the independent variable and the adoption of Agroforestry by farmers in Buuri sub-county was the dependent variable. The results of the regression model are shown in Table 4.24.

Table 4.24: Regression Model Summary for Input Provision to Farmers and Farmers Adoption of Agroforestry Practices

R	R Square	Adjusted R Square	Std. Error of the Estimate
.327[a]	.107	.104	1.03854

a. Predictors: (Constant), input provision total

The model indicates an adjusted R^2 value of ($R^2_{adj.}$0.104, meaning that the independent variable input provision to famers explained approximately 10.4 % of the variation in the dependent variable farmers' adoption of Agroforestry practices. The F test for the regression model is shown in the ANOVA Table 4.25.

Table 4.25: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	p.
Regression	34.352	1	34.352	31.849	.001[b]
Residual	286.899	266	1.079		
Total	321.250	267			

a. Dependent Variable: agroforestry
b. Predictors: (Constant), input provision

The overall regression equation was found to be significant (F (1,266) = 31.849, p < 0.001). The regression coefficients of the model showing the beta, t, and the tolerance levels is shown in Table 4.26.

Table 4.26: Regression Coefficients for Input Provision to Farmers and Farmers Adoption of Agroforestry Practices

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	p.	VIF
(Constant)	1.798	0.137		13.149	0.001	
input provision	0.404	0.072	0.327	5.644	0.001	1.000

a. Dependent Variable: Farmers' adoption Agroforestry practices

The regression analysis (Table 4.25) shows that Input provision to farmers has a positive significant influence (β = 0.327, t = 5.644, p <0.001) on the farmers adoption of Agroforestry practices in Buuri sub-county. It can therefore be concluded that input provision to farmers enhances their adoption of Agroforestry practices significantly.

4.10 Farmers' Collective Action and Adoption of Agroforestry Practices

The fifth objective of this study was to determine how collective action by farmers influences their adoption of Agroforestry practices in Kiirua, Kibirichia and Ruiri wards in Meru County, Kenya.

4.10.1 Farmers Collective Action

The independent variable farmers collective action was operationalized as an index that was developed as a 0, 1 (or dummy variable), where farmers who participated in Agroforestry collective action groups were given a score of 1 and the farmers who did not participate were given a score of 0. The scores were then summed up to provide the index of farmers' collective action. The descriptive statistics and the frequency distributions are given in Table 4.27.

Table 4.27: Descriptive Statistics and Frequency Distribution of the Index of Farmers Collective Action

Scale	Frequency	Percent
.00	55	20.5
1.00	213	79.5
Total	268	100.0

Mean 0.794±.024, median 1, mode 1, Std. dev .404, minimum 0, maximum 1

4.10.2 Analysis of the Influence of Farmers collective Action on Adoption of Agroforestry Practices by Farmers in Buuri Sub-county

The fifth research question for this study was stated as follows: how does farmers' participation in collective action influence the adoption of Agroforestry practices by farmers in Buuri sub-county?

The question was answered by determining the relationship between the two variables using the bivariate linear regression, where the index of farmers' collective action formed the independent variable and the adoption of Agroforestry practices by famers formed the dependent variable. The results of the regression model are shown in Table 4.28.

Table 4.28: Regression Model Summary for Farmers Participation in Collective Action and Farmers Adoption of Agroforestry Practices

R	R Square	Adjusted R Square	Std. Error of the Estimate
.418[a]	.174	.171	.99852

The model indicates an adjusted R^2 value of ($R^2_{adj.}$0.171), meaning that the independent variable farmers participation in collective action explained approximately 17.1 % of the variation in the dependent variable farmers' adoption of Agroforestry practices. The F test for the regression model is shown in the ANOVA Table 4.29.

Table 4.29: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	p
Regression	56.039	1	56.039	56.205	.001[b]
Residual	265.212	266	.997		
Total	321.250	267			

a. Dependent Variable: Farmers' adoption of Agroforestry practices
b. Predictors: (Constant), farmers' collective action

The overall regression equation was found to be significant (F (1,266) = 56.205, $p <$ 0.001). The regression coefficients of the model showing the beta, t, and the tolerance levels is shown in Table 4.30.

Table 4.30: Regression Coefficients for farmers Collective Action and Farmers Adoption of Agroforestry Practices

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	p	VIF
(Constant)	1.582	.135		11.748	0.001	
collective action	1.132	.151	.418	7.497	0.001	1.000

a. Dependent Variable: agroforestry

The regression analysis (Table 4.30) shows that farmers participation in collective action groups has a positive significant influence ($\beta = 0.418$, $t = 7.497$, $p < 0.001$) on the farmers adoption of Agroforestry practices in Buuri sub-county. It can therefore be concluded that participation of farmers in collective action groups enhances their adoption of Agroforestry practices significantly.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter covers the summary of the research findings and presents discussion on the responses to the study objectives. The chapter also presents conclusions that addressed answers to study questions, highlights recommendations to be implemented and give suggestions for further research on gaps identified by the researcher during the study.

5.2 Discussions of the findings

The study sought to establish the influence of government policies and household characteristics on adoption of selected agroforestry practices in Kiirua/Naari, Kibirichia and Ruiri/Rwarera wards in Meru County. The variable government policy was measured using training, provision of inputs and collective action group, household characteristics was measured using, farm size, household number and Education levels.

5.2.1 influence of Household Characteristics on the Adoption of Agroforestry Practices

The findings of this objective indicates that household characteristics (number in the household and education level) had no statistical significant influence on the adoption of agroforestry practices by farmers in Buuri sub-county in Meru County.

The study findings on household preference on decision making on adoption of agroforestry practices revealed that household preference determined the tree species that was grown on the farm. Earlier Studies done in the county tend to concur with these findings (Carsan, & Holding, 2006; Lengkeek, Kindt, van der Maesen, Simons, & van Oijen, 2005). Similar findings by Oino and Mugure (2013) concur with the two

findings that households have been planting trees in their farms, for a long time for other reasons such as fire wood, fodder, fruits, medicine, shade and other purposes. A study by Olumide (2015) concurs with the study arguing that tree planting was conceived a long time ago as strategy to meet the needs of the local people and environmental protection in the 1970s. The findings were supported elsewhere by Thangata and Alavalapati (2003) in that farmers were interested in planting trees on their farms for economic benefits. Contrary to current findings reported by Mustapha *et al*. (2012) that household preferences have an impact on adoption of new agricultural technologies, this mostly was due to house hold preferring to what they usually plant other than what they don't know.

The study also observed agroforestry techniques practiced in the study area. It was revealed that trees planted on rows was an indication that farmers preferred techniques that did not hinder food production. The findings from the study agrees with Nyanga (2016) who noted, farmers have been practicing agroforestry in their farms without the agroforestry technique but through cultural or community believes. In addition, Olujobi (2018) also noted that adoption of agroforestry techniques was a strategy to solve the problem of soil nutrients depletion.

The rate of preference of Eucalyptus and grevillea tree species in the study area could be attributed to the several benefits within short time after tree establishment. This is well supported by Alavapati *et al*. (1995) that technologies that take long time for their benefits to be realized may not be affordable to subsistence farmers. The study findings agree with Nyamweya (2017) who noted the farmers rated the different tree species according to their different purposes. Some rated the tree on their uses such

as, fuel, fodder building material and the income they generate. Similarly, Mgeni (2008) also noted the famers preferred different tree species according to how they ameliorate the effects of climate change, stabilizing soil erosion and improving water and soil quality. He further argues that farmers only select the tree species based on the short payback period as compared to those prone to attacks and fire.

During the study it was also observed that majority of the household sizes was medium. This finding differs with Ayuya (2012) who argued that a bigger household size influences adoption of selected agroforestry, he stated that the large household size will provide labor demanded. He argued that larger households would prefer to adopt new agroforestry practices than small farm holders who tend to be conservative

Education from the study findings was not one of the factors which limited adoption. The findings from the study disagrees with report by Munner (2008) that awareness has a positive influence on the adoption of technologies including Agroforestry practices. Thangata and Alavalapati (2003) report that non adopters of Agroforestry had higher awareness than adopters agrees with the study findings. Nyamweya (2016) established that household education level has a significant relationship with the adoption of agroforestry practices. In their study Awalola and Ajibefun (20120 further noted that an educated household head significantly influences adoption of agroforestry practices. These findings are supported by Olujobi (2018) who argued an educated household is in a position to get information on the importance of practicing agroforestry. Being literate benefits the farmers since it enables them access information on agroforestry practices and the type of tree species to plant.

5.2.2 Influence of Farm Size on the Adoption of Agroforestry Practices

The study also observed the factors which could influence adoption of agroforestry practices. Farm size was identified as a limiting factor to agroforestry adoption in that smallholder farmers are resource poor. It was revealed that farmers with smaller farms failed to adopt some of the agroforestry innovations. Oino and Mugure (2013) agrees with the study that farm size has an influence on adoption of selected agroforestry practices. The larger the piece of land the more the farmer plant trees. Nyamweya (2017) concurs with the study that farmers owning a big size of farm are likely to adopt agroforestry practices. In cases where the size of the land decreases the farmers also tends to reduce practice of agroforestry and instead, they plant food crops. Kabiru, Hassan, Hadi, Umar, Musab and Bello (2018) in their study reported that limited land has a significant influence on the adoption of agroforestry practices.

5.2.3 Influence of Farming Input Provision on the Adoption of Agroforestry Practices

The study findings majority of the farmers get input from government and non-governmental organizations and that farm input have a high influence on the adoption of Agroforestry practices. Lack of income limits the farmers to adopt the Agroforestry systems, an implication that the farmers in area of study are resource poor in terms of financial situation. Alavalapati *et al*. (2008), affirms that income is essential for agroforestry adoption to work. Further the study revealed that high income earners are able to purchase the required seedlings and afford labor unlike low income earners who may prefer not to adopt agroforestry practices.

The fact that household size affect household income is well supported by Tefera (2016) who argued that household size is positively significant in the adoption of Agroforestry practice.

5.2.4 Influence of Government Policy on the Adoption of Agroforestry Practices

The results on government policy influencing adoption of agroforestry practices. The findings from this study differs with Tefera (2016) who argued that for farmers to adopt selected agroforestry practices it is important for the concerned authorities to ensure extension officers visit the farmers. The visits approach enables the farmers to be aware of the importance of adopting selected agroforestry practices. David et al (2017) concurs that having extension officer's agent visit sensitizes the farmers on the need to adopt selected agroforestry practices. Further Kabiru et al (2018) also agreed that extension services visiting the farmers facilitates adoption of selected agroforestry practice. Lambert and Ozioma (2011) also agree with the study that farmers contact with extension agents positively relate to agroforestry adoption rate. Visits of extensions agents to farmers creates and increases awareness of agroforestry knowledge and improves on the farmer's attitude. Ineffective communication about benefits and characteristics of Agroforestry technologies between the agents and farmers results into poor knowledge of the practices thus failing to adopt the agroforestry practices.

From the findings majority of the farmers did not receive any material support to aid in adoption of agroforestry. Contrary to Chitakira and Torquebiau (2010) report affirming that extension, technical and material support as major benefits farmers receive from external agencies. Nyamweya (2017) noted that the concerned authorities' failure to provide seedlings to farmers led to farmers not adopting agroforestry practice. This has a negative impact to the farmers since they are not able to decide the best seedlings to plant. Ndengahe (2013) argues that providing the right seedling enables the farmers to select the right species of trees to plant, that have the

economic value rather than random selecting trees species that have no economic value.

Based on the study findings, it emerged that minority of the farmers belonged to groups. This hinders adoption of agroforestry practices due to lack of right information and slows down the rate of dissemination of information as argued by some key informants during the study. This resonates with Maluki *et al*., (2016) report that farmers not belonging to a collective group hinders adoption of selected agroforestry practices. In addition, belonging to a collective group enhances the farmers to access new information and at the same time provide opportunity to other services on agroforestry adoption. Magugu *et al* (2018) agrees that belonging to a group facilitates easy access to farmers by the concerned authorities. Olujobi (2018) agrees that farmers belong to a group creates an avenue for the authorities to easily access the farmers and at the same time creates a forum for the farmers to educate one another on the importance of adoption of selected agroforestry practices.

The major activity in the area of study was established to be faming. Sebukuyu and Masano (2012) agree with the study that farming is an activity practiced by many farmers. Farmers may increase their revenue if they include agroforestry in their farming.

The results show high adoption of agrosilvopastroral could be attributed to the fact that agricultural crop production to be the main economic activity in the area of study. The results compare well with Mathew & Sarah (2016) report that intentional combination of trees and shrubs with crops or livestock is the next sustainable agriculture. For land tenure it was revealed that majority of the farmers owned the

land. This could have promoted adoption of agroforestry practices but it was contrary to the expectation of Key informants. This resonated with report by Ajayi (2003) that farmers with small plots of land struggle to produce sufficient food and cannot take land out of food production and out it under conservation purposes.

5.3 Summary of Main findings

The study revealed that household preferences influence the adoption of agroforestry practices even if it does not facilitate the adoption of agroforestry practices. The researcher established that tree planting in rows was the main agroforestry technique practiced as it did not interfere with agricultural crop production in the small land parcels in the area if study.

Based on the results, it emerged that, farmers income is from farming since most of them were subsistence farmers. This income was affected negatively by the size of the family. Also, it was revealed that households with many members were able to make more income as these members could offer labour services in the farm reducing significantly the amount to be paid out for labour.

The study further noted that government policy significantly influences the adoption of selected agroforestry practice. This was portrayed by lack of extension agents visiting the farmers, lack of provision of seedlings and farmers not belonging to a collective group. This hinders adoption of selected agroforestry practices. Although the results revealed attendance of demonstrations and trade fairs, it was noted that the topics covered did not promote or impact on agroforestry practices but rather on agricultural crop production.

5.4 Conclusions

Based on the study results, the following conclusions have been drawn:

(i) The government policies have significantly influenced adoption of selected agroforestry practices. This was revealed by poor or lack of extension visits, the lack of material support and lack of formal forums to impact on matters of agroforestry practices. This becomes an impediment to accessing information about agroforestry practices and limits the concerned authority to educate or sensitize the respondents on the importance of practicing agroforestry.

(ii) Lack of Agroforestry knowledge, land shortage and lack of formal income are some of the factors that limit adoption of Agroforestry practices.

5.5 Recommendation

The study recommends that:

There is need to train both extension officers and farmers to solve the problem of Agroforestry knowledge. The County government in collaboration with the National government to publish training materials to promote Agroforestry practices.

The county government officials should collaborate with other stakeholders to organize demonstrations, field days as a way of enhancing awareness on matters related to Agroforestry and group formation to facilitate easy information sharing and provide an education platform that will reach many farmers in Meru County within a short period of time.

Lack of formal income can be solved by government by providing credits through farmer groups'

Lack of material support can be solved by educating the community to have their own tree nurseries for trees accessible to their group members and surrounding communities.

5.6 Areas of further study

This study concentrated on the influence of government policies and household characteristics on adoption of agroforestry practices. The study suggest that extensive studies should be carried out on information communications technology and economics activities and how they influence adoption of agroforestry practice.

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APPENDICES

Appendix A: Questionnaire

PART A: LOCATION

1. Location Name .....

2. Ward Name .....

3. Village Name .....

PART B: HOUSE HOLD PREFERENCES

Please indicate by ticking if you agree with each of these statements.

4. Household preferences influence the decision on adopting selected Agroforestry practices.

Yes ..... No.....

5. Do you think household preferences facilitate selected agroforestry adoption?

Yes ..... No.....

6. Indicate by ticking the adoption of Agroforestry practices technique in your farm

Techniques	
Tree planting on rows	
Tree planting on terraces	
Orchards	
Woodlots	
Tree planting on fence	

7. Rate the tree species in order of preference

Species	1	2	3	4	5
Grevillea					
Sesbania					
Caliandra					
Cypressus					
Eucalyptus					
Cordia					

PART C: FARM SIZE

7. a) what is the size of your farm?.....

b) How many trees seedlings have you planted in your farm?.....

.....

.....

PART D: INCOME

8. Please indicate and rate the source of income which supports your livelihood

Source	1	2	3	4	5
Farming					
Formal employment					
Informal employment					

9. Does household size affect your income? .....

10. How many are you in your household? .....

PART E: EDUCATION LEVELS

11. Indicate by ticking your years of formal education

Educational level	
Primary school	
Secondary	
College	
University	
Others	

PART F: POLICY

Training

12. How many demonstrations have you attended No { } Topic covered …….

13. How many trade fairs have you attended No { }

14. How many extension agents have visited you No { } Topic covered…….

Provision of Inputs

15 Have you received any seedlings to aid in adoption of agroforestry? Yes { } No { } Species…….

Collective action group

16. Do you belong to any group? Yes…… No……..

17. What are the activities you undertake? Please indicate by ticking

Activities	
Farming	
Animal rearing	
Tree planting	
Agroforestry	

PART F: TYPES OF AGROFORESTRY PRACTICED

18. Which of the following agroforestry practices do you engage in? Please indicate by ticking

1.	Mulching with Agroforestry Practice	
2.	Alley farming	
3.	Planting crops and trees	
4.	Planting trees, crops and keeping animals	
5.	Fodder banks	
6.	Boundary marks	

19. What type of land tenure do you practice? Please indicating by ticking.

1.	Inheritance	
2.	Renting and leasing	
3.	Purchasing	
4.	Government scheme	

20. Checklist of probe for ward/ farm forestry and agricultural extension officers

1. Does your ward practice agroforestry?
2. What is the current status of Agroforestry practice in your ward?
3. What is the current agroforestry extensions approaches used in the area?
4. What extension approaches do you think would be appropriate to promote agroforestry adoption in the area?
5. What constraints do you face in implementing extension services?
6. What limitations do farmers face in adopting the Agroforestry practices?
7. What are your suggestions for success of Agroforestry practices in this area?

Appendix B: Field Photos

An Agroforestry system: showing maize and tees in the background

Trees planted on the boundary of the farm with maize crop

Alley cropping with Napier grass and Grevillea trees on the boundary

Trees on the farm boundary

Maize crop with trees forming the boundary

Trees, Napier graas on the terraces

Agroforestry systems in the study area

Alley farming Napier grass, Trees and a prepared field for cropping

Trees planted on the farm boundary

Bananas, trees and maize crop

Appendix C: Introductory Letter

AFRICA NAZARENE
UNIVERSITY

12th June, 2018

RE: TO WHOM IT MAY CONCERN

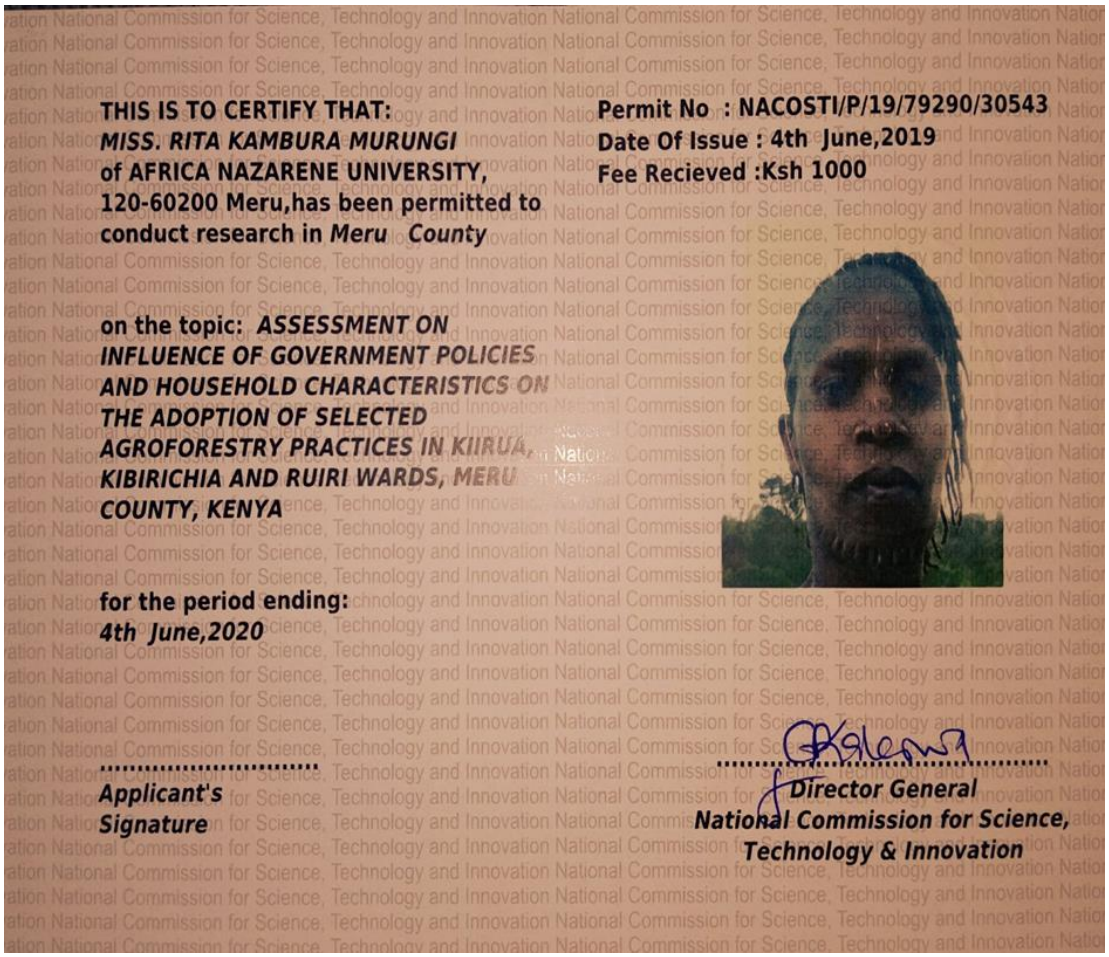
Rita Murungi 18J01DMEV002 is a bonafide student at Africa Nazarene University. She has finished her course work and has defended her thesis proposal ***entitled "Assessment on Influence of Government Policies and Household characteristics on the Adoption of Selected Agroforestry Practices in Kiirua, Kibirichia and Ruiri wards, Meru County, Kenya"***

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

Rodney R. Reed

Prof. Rodney Reed
Deputy Vice Chancellor, Academic Affairs

Appendix D: Research Authorization



THIS IS TO CERTIFY THAT:
MISS. RITA KAMBURA MURUNGI
of AFRICA NAZARENE UNIVERSITY,
120-60200 Meru,has been permitted to
conduct research in *Meru County*

Permit No : NACOSTI/P/19/79290/30543
Date Of Issue : 4th June,2019
Fee Recieved :Ksh 1000

on the topic: *ASSESSMENT ON INFLUENCE OF GOVERNMENT POLICIES AND HOUSEHOLD CHARACTERISTICS ON THE ADOPTION OF SELECTED AGROFORESTRY PRACTICES IN KIIRUA, KIBIRICHIA AND RUIRI WARDS, MERU COUNTY, KENYA*

for the period ending:
4th June,2020

.....
Applicant's Signature

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