

**FACTORS INFLUENCING THE ADOPTION OF
MODERN AGRICULTURAL TECHNOLOGIES BY
SMALL SCALE FARMERS: THE CASE OF THIKA
EAST SUB-COUNTY, KENYA**

BY

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DECLARATION

This research project report is my original work and has not been presented for any award in other institution.

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DEDICATION

To my wife edinah, daughter Tiffany and my parents; Mr.John Nyangoto and Mrs Teresa Nyaboke, my brother Caleb and my sister Loice for their moral and financial support during this project undertaking. Without their support I would not have completed my masters studies.

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LIST OF ABBREVIATIONS AND ACRONYMS

AI- Artificial Insemination

AFC- Agricultural Finance Corporation

ASPS- Agriculture Sector Programme Support

DOI- Diffusion of innovations

FAO- Food and Agricultural Organization

FFSs- Farmer Field Schools

GAP- Global Agricultural Productivity

GE- Genetic Engineering

KAPP- Kenya Agricultural Productivity Project

KARI- Kenya Agricultural Research Institute

NAAIAP- National Accelerated Agricultural Inputs Access Programme

NALEP- National Agriculture and Livestock Extension Programme

SPSS- Statistical Package for Social Sciences

TC- Tissue culture

T&V- Training and Visit

ABSTRACT

Agricultural productivity in Kenya can only be enhanced through the adoption of modern agricultural technologies by the farmers the aim of the study was to find out the factors influencing the adoption of modern agricultural technologies by small scale farmers. The study was guided by the following specific objectives; to establish the influence of access to resources on the adoption of modern agricultural technologies by small scale farmers, to determine the influence of access to extension services on the adoption of modern Agricultural technologies by small scale farmers, to determine the influence of access to modern agricultural technologies' information on the adoption of modern agricultural technologies by small scale farmers and to establish the influence of access to agricultural research activities on the adoption of modern agricultural technologies by small scale farmers. Descriptive survey was employed as the research design. The study sampled a total of 127 small scale farmers from a target population of 200 small scale farmers the sample was drawn from three villages within Thika East Sub-county namely; Ithanga, Magogoni and Nanga sampled using simple random sampling technique. The study also sought the opinion of 8 extension officers and 10 KARI Thika research scientists. Data was collected using questionnaires and as the main primary data collection tools distributed to all the 144 respondents. Data was analyzed using the Statistical Package of Social Scientists version 22.0. Descriptive statistics such as frequencies and percentages were used to organize and simplify the collected data. Karl Pearson product moment correlation analysis was also employed to determine the direction and strength of relationship between some variables of interest. The results obtained showed that farmers have a low access to resources; credit facilities at 9%, agricultural inputs, water, equipments and machineries at 11% because of the high input prices, low government support and inadequate access to financial resources by farmers also 94% of the farmers practice their agricultural activities on land of size less than 5 acres. A strong positive correlation of a correlation coefficient of 0.6 was also obtained between the levels of the farmers' average monthly income and access to agricultural input and equipments. Access to extension services and agricultural research centers and their research products by farmers is also low within the sub-county with only 26.4% and 18.2% of responding small scale farmers agreeing to have accessed extension services and agricultural research centers and their products in that order. Most respondents agreed that small scale farmers access information on modern agricultural technologies for instance, 90% of the small scale farmers agreed to have accessed information on modern agricultural technologies through; electronic and print media, extension officers and other farmers with the level of education playing a critical role in selection of the information sources the farmer will use to obtain agricultural information. From the findings it was concluded that low access to resources, extension services and agricultural research centers and their research products negatively influences the adoption of modern agricultural technologies within Thika East sub-county. Thus, it was recommended that, the government should employ more extension staff and deploy them to more decentralized levels like sub- locations and villages so that contact between the farmers and the extension officers is improved the government should also lower the interest rates charged on loan facilities granted to small scale farmers so as to make it easier for them to access credit facilities from the major lending financial institutions. Further the government should subsidize the prices of inputs, equipments and machinery required for the adoption of modern agricultural technologies to make them more affordable to the farmers. Further the government should facilitate the decentralization of agricultural research activities by supporting the main research centers to establish sub-centers into the rural areas in Kenya to make them more accessible to the rural farmers.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Agriculture over the recent years has emerged, with greater potentials, as the backbone of the world's economy in most countries; agriculture is also a major source of income for almost 50% of the world's population (Abdullah et al, 2005). Agriculture supports directly and indirectly the entire world's population by providing food thus forming a major base for overall development and progress in most countries. In Kenya for instance, 70-80% of the population who live in rural areas fully depend on agricultural activities as their main source of food and income (Marshall and Miguel, 2014), agriculture also absorbs about 45% of the Kenyan's labour force into formal, informal and self-employment opportunities, further it contributes about 60-70% of the country's export and foreign exchange earnings, and overly every single year agriculture contributes 21% of the Kenyan Gross Domestic Product (Ayesha and Muhammad, 2012). Agriculture has thus played a critical role in both poverty reduction more so in the rural areas and to a very large extent it has promoted economic growth for most countries in the world.

The Agricultural sector in Kenya has been touted as one of the six sectors aimed at delivering 10 % economic growth and development for the realization of Vision 2030 (Langat et al, 2014). In Kenya like in many other developing countries however, agricultural productivity is still extremely low, therefore, increasing agricultural productivity is critical because it will promote; high sustainable economic growth, overall economic development and thus ensure the realization of vision 2030 which is only 14 years away. Improvement of agricultural production, productivity and sustainability will only depend on the farmers' willingness, to access, practice and adopt new agricultural technologies and innovations being developed and disseminated by the government funded agricultural research centers and other private companies across Kenya and from other parts of the world. Wanyama et al (2013) notes that the adoption of modern agricultural technologies by farmers in Kenya can increase farm productivity

then subsequently increase household incomes, promote food security and finally provide more employment opportunities for the many unemployed Kenyan citizens.

Agricultural technologies available to small scale farmers have been one of the major resources for modern agricultural production; technological change has been identified as a major factor shaping agriculture in the last 100 years. According to Ingold (2002) failure by small scale farmers to accept, apply and adopt modern farming technologies on their farms so as to promote productivity in the major food production systems has led to very low agricultural productivity and thus the escalating food insecurity and poverty problems in Africa. Langat et al (2014) noted that slow adoption rates of Agricultural technologies continue to hinder Africa's food insecurity reduction programmes as well other farmers' agricultural economic empowerment initiatives that have been put in place by different government and non-government agencies.

One important way of increasing agricultural productivity and thus solve problems arising from low agricultural productivity in developing countries is through the development and generation of new and modern agricultural technologies and finally dissemination of the same technologies to farmers for adoption (Mapila, 2011). But, adoption of novel agricultural technologies in Kenya and the rest of the sub-Saharan Africa still remain very low. The predominant role of modern technology adoption in any agricultural enterprise is facilitating major improvements in the production processes and systems thus, enhancing agricultural productivity, economical use of the agricultural production resources and thus long term sustainability of the whole process. Adoption of agricultural innovations and technologies by small scale farmers is extremely important for the country's agricultural sector and consequently for the economic empowerment of the people in the rural areas. Technologies can provide solutions to many of the agricultural, social-economic and environmental problems faced by the rural people in local communities (Langat et al, 2014) for instance; adoption of modern irrigation techniques for instance, the use of drip irrigation can promote effective water use and management during prolonged dry seasons. Türkyılmaz et al (2003) also noted that one way of reducing production costs in agricultural enterprises is through the acceptance and

application of the state of the art modern agricultural technologies. The use of modern agricultural technologies will contribute to the general improvement of the economic well-being of the farmers in short term and the living condition of all community and society members in the long term (Boz et al, 2002). Ahuya & Okeyo (u.d) also notes that adoption of efficient and sustainable agricultural practices remains the single most promising options of sustaining agricultural productivity. Kinyanjui (2012) also found out that increased agricultural productivity can be attained through sustained access and application of improved agriculture technologies by farmers.

The Kenyan government together with other state and private development partners have facilitated, introduced and implemented several efficiency and productivity-enhancing technologies through state and private funded agricultural research activities ongoing in most government agricultural research centers and other private companies, most of the end products of this agricultural research projects have been disseminated to the farmers. Improved technologies for instance; soil and water conservation, improved storage facilities, labor-saving and high yielding hybrid seeds have also been developed and disseminated to farmers, particularly from Kenya Agricultural Research Institute (KARI) and agricultural university research centers, but, the rate and intensity of adoption and spread of these technologies to and among farmers is still very low. Therefore, a common problem for many individual research scientists and research organizations is how to speed up the rate of uptake, diffusion and adoption of the on-going agricultural research activities, innovations and other technologies which have been disseminated to farmers (Rogers, 2003). Speeding up the rate of adoption of modern farming technologies requires knowledge and understanding of the factors that influence and determine the technologies adoption decisions by the farmers.

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

social factors that have identified to influence the chances of adoption by a farmer include; the farmer's age, level of education, gender and his social groupings. Institutional factors that influence and determine the rate of agricultural technologies adoption and uptake by farmers include; access to information about the technologies through the existing and accessible information sources, nature of policies and provisions enacted by the government and access and nature of the extension services provided. As Langat et al (2013) also noted adoption of modern agricultural technologies by small scale farmers is both externally and internally challenged and hindered by a wider range of factors which have led to most farmers adopting modern technologies at alarmingly slower rates. Physical environmental factors are those external factors that determine how the farmers will adopt the existing modern technologies and they include factors such as; natural calamities for example prolonged droughts and floods some of the physical factors are well beyond the control of the local subsistence farmer, other external factors include; poor quality and sub-standard farming technologies being disseminated to farmers and non-supportive government policies that have been put in place by the existing government departments. Internal factors include; pests and disease, soil infertility, land availability and faster population increase

1.1 Stament of the problem

Many modern agricultural technologies are available in Kenya; most of them have been developed and disseminated by the agricultural research centers in the county including the 29 KARI research centers. Examples of modern agricultural technologies that have been disseminated to farmers in Kenya today include; improved maize open pollinated varieties, hybrid seeds, chemical packages, improved on farm storage techniques, post-harvest handling techniques, methods of small scale Irrigation such as treadle pumps, Greenhouse farming, drip irrigation, fertilizer application through fertigation systems, Artificial insemination, in-vitro tissue culture plant breeding and many others. Low adoption of modern agricultural production technologies amongst farmers in Kenya and in many other developing nations has been identified as one of the main reasons for the low agricultural productivity (Mamudu et al, 2012; Umeghalu et al, 2012). Drosch (2015) and Singh et al (2014) also notes that low technology adoption by the small scale farmers has been the main hindrance to the realization of higher agricultural productivity

most developing countries. In Kenya for instance, despite the efforts that have been made by the Kenyan government, development partners and the Ministry of Agriculture, the levels of modern agricultural technology adoption by farmers in Kenya still remains very low (Republic of Kenya, 2007 ; Ogada et al, 2010). For instance, the adoption rates are as low as 12 percent for inorganic fertilizers (Olwande et al, 2009) much lower than 30 percent for hybrid maize varieties (Alliance for a Green Revolution in Africa, 2010). Kinyanjui (2012) also discovered that despite the technologies that have been disseminated their adoption by dairy goat farmers at the individual farm levels remains low and productivity also continues to be low thus contributing to low sustainability of goat farming enterprises in Kakuzi Division within Muranga County.

Adoption of improved cultivars for major food crops is also very low in the entire Thika East-sub County and despite their potential of high yields; most farmers in Kenya are yet to take up tissue culture bananas developed through biotechnology (Olembe, 2010; Kikulwe et al, 2012; Kabunga, 2012). Less than 10 percent of all banana farmers in Kenya have so far taken up Tissue Culture bananas (Njuguna et al, 2010). Minimal adoption rates of 15 percent have been reported in Central and Eastern Provinces where most of the dissemination programs of biotechnology breeding systems started (Kabunga et al, 2012). Very few farmers in Thika East sub-county region where the study was carried out have adopted Greenhouse farming, Drip irrigation, fertigation and chemical application systems or Artificial insemination in their livestock farming. Finding out the factors responsible for low technology uptake among the farmers is critical (Mamudu et al, 2012) and while, the findings of low levels of technology adoption are well accepted in Kenya, very few studies have been carried out determine the factors that influence the adoption rates of modern agricultural technologies in Kenya more so in Thika East sub-County, the region where this study was be carried out. Therefore, this research study intended to fill that existing knowledge gap.

1.2 Purpose of the study

The research study investigated the factors influencing the adoption of modern Agricultural technologies by small scale farmers in Thika East Sub-County.

1.3 Objectives of the study

The research study was guided by the following specific objectives;

1. To establish the influence of access to resources on the adoption of modern Agricultural technologies by small scale farmers.
2. To determine the influence of access to extension services on the adoption of modern Agricultural technologies by small scale farmers.
3. To determine the influence of access to modern agricultural technologies' information on the adoption of modern Agricultural technologies by small scale farmers.
4. To establish the influence of access to agricultural research activities on the adoption of modern Agricultural technologies by small scale farmers.

1.4 Research Questions

The study was guided by the following research questions;

1. To what extent does access to resources influence the adoption of modern Agricultural technologies by small scale farmers?
2. How does access to extension services influence the the adoption of modern Agricultural technologies by small scale farmers?
3. How does the access to modern agricultural technologies's information influence the adoption of modern Agricultural technologies by small scale farmers?
4. To what extent does agricultural research activities influence the adoption of modern Agricultural technologies by small scale farmers ?

1.5 Significance of the study

Through the study factors that influence the adoption of modern Agricultural technologies by the small scale farmers were understood, the factors and recommendations if implemented fully they will assist the technology disseminators to effectively disseminate the technologies to the farmers in a way that the rates of their diffusion and adoption by the farmers will be increased. If the recommendations given as per the research findings will be implemented fully higher levels of modern technologies adoption by the small scale farmers will be attained leading to increased agricultural

productivity thus promoting higher economic growth and rural development in the country

1.6 Assumption of the study

It was assumed that in the course of the research study that;

1. The respondents identified the factors and variables influencing the adoption of the modern Agricultural technologies.
2. The respondents who participated in the study were willing to provide factual and objective information on the topic of study.

1.7 Limitations of the study

The core respondents of this research study were the small scale farmers, most of the small scale farmers were of low literacy levels very few of them had formal education above secondary school level (10% have never attended school, 2009 census report) thus, it was a challenge for them to fill the tools of research. This problem was reduced by the recruitment of six research assistants who understood the local languages; they were trained and greatly assisted the researcher in data collection from the small scale farmers.

The Kenya Agricultural Research institute (KARI) –Thika center research scientist and the Thika East sub-county Agricultural extension officers who were also interviewed some of them were reluctant to give correct information but the researcher constantly explained the importance of the research study to all of them thus, making them realize the importance of giving factual information on the research topic which to a very large extent reduced the challenges that related to not giving or being reluctant to giving factual information on the topic of study.

1.8 Delimitations of the study

The research study was carried out in Thika East Sub-county found within Kiambu County delimited to a sample of small scale farmers in the region selected from three villages namely; Ithanga, Magogoni and Nanga. This area was selected because it has a

large number of small scale farmers, some of have adopted modern Agricultural technologies being disseminated by the government and private agricultural research institutions found in the region. The study was also delimited to Kenya Agricultural Research institute (KARI) –Thika center research scientists and extension officers operating within Thika East Sub-county.

1.9 Definations of significant terms and concepts used in the study

Adoption of modern agricultural technologies; adoption is adcribed as the whole process of receiving information about modern agricultural technologies available then making decisions of bringing the technologies into practice.

Agricultural research activities; they include the on-going agricultural scientific processes, procedures and operations whose sole aim is to produce new agricultural practices, services and products. Agricultural research activities are undertaken by agricultural research centers. The major agricultural research centers in Kenya include; Kenya agricultural research institute, Seed companies and University agricultural research centers.

Agricultural technologies’ information; processed data that conveys useful and understandable meaning about scientifically researched and derived agricultural practices and products, once accessed by farmers agricultural technologies’ information can be used by the farmers to make a decision to adopt any given technologies.

Extension services: they are all set of actions by agricultural government organizations and their employed personnel that supports and facilitates people engaged in agricultural production activities (farmers) in order to solve existing agricultural problems through the process of passing information, skills and knowledge to them.

Resources: they include all the physical equipments, materials and financial requirements required to facilitate the agricultural production process for this study; agricultural inputs, land size and credit facilities were considered as resources.

Small scale farmers; those farmers who practice agriculture and farming on smaller pieces of land of sizes less than five acres growing different types of crops and rearing livestock on the same pieces of land for subsistence purposes.

1.10 Organization of the study

This research study report is divided into five chapters; chapter one covers the introduction of the study given through detailed background information of the study, statement of the problem, purpose and objectives of the study among others. Chapter two covers the literature review which includes a detailed theoretical framework, a conceptual framework that describes the various dependent and independent variables that were studied plus their indicators while chapter three covers the research methodology used outlining the; target population, sample size, sampling techniques used, instruments of data collection, data collection procedures and data analysis methods in addition chapter three covers how the validity and reliability of the data collection instruments was measured. Chapter four covers; data analysis, presentation, interpretation and discussion of findings while chapter five gives the entire study's summary of findings, conclusions drawn as per the study's objectives, recommendations of the entire study and suggestions for future research studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter gives the literature review conducted on the adoption of modern agricultural technologies and factors influencing the adoption of modern agricultural technologies by small scale farmers mainly; resources, extension services, modern agricultural technologies' information and agricultural research activities. Two models are also applied in this chapter to theorize on how adoption of modern agricultural technologies and innovations is influenced by different factors and attributes. In this chapter the study is further enhanced by a conceptual framework detailing the link between the various independent variables that were studied with their respective indicators to the dependent variable; adoption of modern agricultural technologies by small scale farmers.

2.2 Adoption of modern Agricultural technologies

Adoption of innovations or technologies is described as the whole process of receiving information about the existing modern technologies which then guides the adopters in the decisions making process then bringing the technologies into practice followed by further spread of the same technology to other individuals in the community. Adoption of technologies is not a single act but a multi-process with many stages and as Rodgers (2003) notes the adoption process starts when a farmer is exposed to information on given innovations and technologies, considers the information, and finally makes decisions to accept and practice those particular innovations or technologies on his farm. Technologies reach the farmers through the general process of technology transfer, technology transfer being the entire process of moving and passing information and skills about technologies from the agricultural research centers and universities through existing and accessible communication channels to the clients (farmers). As the Global Agricultural Productivity (GAP) (2011) report notes many countries including; Brazil, China and the United States have greatly benefited from the spread and adoption of the science-based technologies for instance; plant breeding through biotechnology, Global

Positioning System (GPS) - guided equipments and the other best science based agricultural management practices.

The availability and access of the modern agricultural production technologies by farmers and actual utilization these technologies by farmers on their farms is very critical in any agricultural production system (Mamudu et al, 2012). Most technologists and agricultural scientists developing new innovations believe that the new agricultural practices with obvious benefits will be naturally taken up and adopted by farmers within a very short time because the benefits of the new ideas will be widely realized by the potential adopters, and that the innovation will therefore spread rapidly to and among all the community members (Toborn, 2011). However, according to Rodgers (2003) most innovations that have been developed and disseminated to farmers have been slowly rates taken up for example the Ghanaian agricultural sector is characterized by low levels of technology uptake by farmers and according to the Ghana's Ministry of Food and Agriculture (2010) low technology adoption is the main contributor to low agricultural productivity being experienced in that country. Numerous interventions have been enforced by respective governments in many countries including Kenya to promote modern technology uptake by farmers but the rates of adoption are still low despite the efforts (Mamudu et al, 2012).

The visible indicator of new technologies transfer from the agricultural research centers to farmers is the farmers' actual adoption and practice of the adopted technologies on their farms and then further diffusion to other community members. Diffusion of technologies being the process through which innovations are spread and communicated through the existing communication channels over time among and to other community members (Rogers, 2003). Diffusion of technologies results from a series of individual farmers' mental and physical decisions to accept and begin using the new technologies; these decisions are based on an economics analysis where a comparison of the expected benefits of the new innovation with the uncertain costs of adopting it. In most case farmers will adopt technologies when the expected benefits expected after the adoption out-weighs the costs incurred during the adoption process.

Any farming population can be divided into three subdivisions in terms of agricultural technologies adoption; early adopters, followers, and laggards according to the diffusion of innovations model and the adopters' categories concept (Rodges, 2003). Parvan (2011) identifies three forms of technology adoption that depends on the types of technologies being adopted i.e. individual verses aggregate adoption, singular verses all packets of technologies available adoption, and divisible verses non-divisible technologies adoption. Singular technology adoption is when; farmers are presented with a single choice of the technologies available for adoption: the adoption of one technology such as new high yielding variety seeds, modern greenhouse farming, and artificial insemination. In packet technologies adoption, the agricultural technologies are introduced in smaller complementary divisible units which must be adopted together for the technology to work. For instance when high yielding variety seeds are introduced along with other complementary fertilizers and corresponding land preparation practices needed to make the high yielding variety seeds grow well or Greenhouse technology farming installed together with drip irrigation and fertigation systems to make the greenhouse operations more efficient. The success of packet technologies adoption depends on the farmer's willingness and his ability to adopt all the complementary divisible packets together at the same time.

Individual adoption is the modern technology adoption process where the final adoption decisions to adopt or not adopt a technology lies at an individual farmer for instance, when an individual farmer decides to adopt given technologies on his farm. Individual adoption process involves an individual mental deliberative process. Aggregate adoption on the other hand is measured and determined at a combined level for use of given technologies among specific groups of farmers. Non-divisible technologies adoption involves uptake of all the complementary technology units together as a whole for example; modern farming practices like the use of tractors and other mechanized inputs are not divisible. But, divisible technology adoption involves; choosing the complementary parts of the technology to adopt for instance, fertilizer can be applied selectively.

Examples of modern agricultural technologies that are available and have been adopted by some small scale farmers in Kenya and other countries in world include; artificial insemination (AI), Tissue Culture (TC) bananas, Greenhouse farming, Hydroponics farming and High yielding hybrid seeds (Kinyanjui, 2012, Mwangi 2013 and Mamudu et al, 2012). But, a few studies have been carried out in Kenya to determine the factors that influence the rate adoption and diffusion of the available modern agricultural technologies by small scale farmers. No much literature though exists to proof that the same studies have been extensively carried out in Thika East-sub County the knowledge gap the study intends to fill.

2.3 Resources and adoption of modern Agricultural technologies

Resources are physical equipments, materials and financial requirements required to facilitate the processes of agricultural production. Though, the farmers may possess all the necessary detailed and comprehensive information about the available modern technologies, inadequate access to critical agricultural resources may hinder the adoption process of those given technologies that the farmers are fully aware of (Truong and Yamada, 2002). For instance, low adoption rates of modern agricultural technologies has also been positively linked to poor access of credit and loan facilities by farmers (Marshall and Miguel, 2014) in the sense that the small scale farmers often lack access to adequate financial resources to meet the high required initial start-up cost required to acquire modern technology facilities and also for the purchase of other critical inputs required during the adoption process. Improved access to credit by small scale farmers, in the form of upfront fertilizers loans, grants of other necessary agro-chemicals and seeds from established seed dealers and established government stores which are paid back after the marketing of the harvested produces can increase the adoption rates of modern agricultural technologies. Modern technology adoption requires initial fixed cost and regular incremental investment of financial resources, especially when the intensity of use of a new technology changes over time the famers must therefore be assured of regular and constant access to financial resources for successful adoption (Sunding and Zilberman, 2000).

Banks perceive smaller farmers more risky during credit application appraisals, small farmers therefore, must compensate for the fixed cost of loan processing for instance, Umeghalu et al found out in Nigeria that credit and other major banking institutions discriminate against the vast majority of the small scale farmers for lack of collateral and guarantees when they apply for loans to invest in their agricultural operations (Umeghalu et al, 2012). Onim in study conducted in the western part of the country also found out that capital availability for agricultural investment was low due to low access to credit and loan advances (Onim, n.d). Access to credit in Kenya is pegged on the provision of collateral before the loan is released to the applicants. The only available collateral for most small scale farmer in Kenya is their agricultural land which most of them are not ready to put up on mortgage in order to access the loans further most small farmers in Kenya do not possess title deeds for the land they own this coupled with the high interest rates charged by commercial banks, poor and inadequate banking services being offered, makes accessibility of loans and credit facilities challenging to small scale farmers even where they are available (Mubichi, 2009).

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

time as the population is also increasing this has greatly limited the land set aside for agricultural practices and thus the adoption of modern agricultural technologies by the farmers. For example, land in regions around and close to Nairobi and Kiambu counties over the recent years has become highly expensive and most small scale farmers have thus been lured to sell their agricultural land for the upcoming Peri-urban Real estate development projects this has greatly reduced the land sizes set aside for agricultural production and thus the adoption of modern agricultural technologies while, Kinyanjui (2012) agrees with the observation about land scarcity and the reducing land sizes, the studies he conducted in Kakuzi division within Muranga county did not establish to what extent the available land sizes influence the adoption of modern agricultural technologies by small scale farmers within Thika East sub-county this study aims to fill the existing knowledge gap.

Access to agricultural production inputs, modern machineries and equipments by farmers has been positively associated to the uptake of modern technologies by farmers but, it has been reported that most small scale farmers in Kenya are unable to afford basic production inputs such as water, fertilizer and other agrochemicals required for the modern farming practices because of the high exorbitant and prohibitive input prices (Kinyanjui, 2012) this has resulted in low technologies uptake by farmers. The economic constraints model one of the three models that have been used to explain the adoption behavior and determinants of technology adoption by farmers, the model explains that; agricultural inputs fixity in the short run for instance, inadequate access to critical inputs for example; water, agro-chemicals and fertilizer limits agricultural production flexibility and thus negatively influences the technology adoption process by famers. Introduction of new technologies by farmers on their farms increases the demand for the other required complementary inputs and when the supply and access of these other complementary inputs is hindered agricultural technologies adoption process will be negatively affected. For instance, during the period of the Green Revolution agricultural transformation in Punjab, India the short period of transition from the use of traditional seed varieties to the adoption of high yielding hybrid seeds, the whole transformation process was largely determined and influenced by the availability of irrigation facilities

and fertilizers together with other production resources like water, land and labour because the yield potential of high yielding hybrid variety seeds, required considerably larger application doses of fertilizer and water per unit of land for its success. The adoption of hybrid seeds was constrained by the availability of water and fertilizer during that period (Singh et al, 2014).

Adoption of modern agricultural technologies that mostly involves the use of agricultural mechanization and adoption only succeeds when all the other required agricultural machines and equipments are manufactured and serviced locally by the local industries, to ensure their acceptability, durability, affordability, reliability, availability and maintainability (Umeghalu et al, 2012) but, in Kenya like in most other developing countries there's low access to the modern agricultural machinery and equipments thus, this has greatly limited the adoption and uptake of modern agricultural technologies that require the use of modern machinery and equipments. Machines' high prices, low access to spare parts because they are not manufactured locally and high operational and servicing cost once the machines are acquired are the main reasons for farmers' low access to credit. In Nigeria for instance, Umeghalu et al (2012) noted that most of the available modern agro-machines and equipments required by farmers for their modern farming operations are imported from the western countries.

2.4 Extension services and adoption of modern Agricultural technologies

Agricultural extension is one of the main government institutional components in any agricultural production system which promotes the transfer and exchange of information and knowledge on agricultural technologies and practices useful to the small scale farmers through set agricultural extension training programs and models. As noted by Christoplos (2010) extension services can be defined as; organized systems that facilitate and enable farmers, other organizations and those in marketing of the agricultural products to access agricultural knowledge and information about the market and farming skills. Extension services facilitate farmer's interaction with other major partners in; agricultural research, agricultural education and agribusiness. Past studies show that Extension services are poorly managed and delivered in Kenya. Improvement in the

management and delivery of agricultural extension by those organizations and personnel in-charge and responsible has been identified as a key solution to the effectiveness of extension services provision and access in Kenya (Lopokoiyit et al, 2013). New technologies developed by researchers are supposed to be transferred and disseminated among and to the farmers by the agricultural extension department. Extension services are supposed to be a connector and facilitator linking the farmers to the agricultural researchers at agricultural research centers and higher level agricultural educational centers. Further, extension trainings foster group's formation among farmers for sharing extension information, they also facilitate agricultural marketing by linking farmers to markets and providing farmers with information on where they can sell their produces. Currently extension services also monitor and evaluate of food security issues and agricultural production systems within local communities (USAID, 2002).

Availability and access to extension services by small scale farmers has a greater influence on the rate of adoption of new modern farming technologies by farmers because extension services facilitate the learning and appreciation process of the technologies being disseminated. Access and provision of extension services in Kenya is hampered by the long distances to the extension offices from the various farming points farmers have to travel long distances to access extension services since over the recent years the government policy on extension services provision in Kenya has changed from extension- driven to demand- driven approach (Kinyanjui, 2012). The government policy on extension is that the farmers are only provided with extension services if they ask for them. This change of policy over the recent years may have been caused by shortage of government employed extension staff, inadequate government resources provided for the provision to the extension services and the realization that the top- down approach extension delivery was not effective. Mohammad (2011) found out that the provision of government supported extension programs to farmers have been in decline across Africa in the recent years. There seem to be little or no study carried out in Thika East sub-county to establish the extent of access to extension services and how it influences adoption of modern agricultural technologies.

The frequency of provision of extension services determines the rate of adoption of new agricultural practices for instance the number of extension visits per year and quality of AI services provided to the farmers by the extension veterinary officers has been positively linked to the adoption and use of AI technology by farmers (Khanal and Gillespie, 2011). Wambugu (2001) also agreed and observed that farmers who were more frequently exposed to government extension services through regular visits by the extension agents the farmers both knew and practiced more modern technologies than those farmers with low and few contacts with extension agents due to fewer number of extension visits. Higher frequency of provision of extension services facilitates the learning process and access to information.

Many extension training methods, techniques and approaches have been used since 1970s, including out-reach training services, adult education, the World Bank's Training and Visit (T&V) model or home and visit method (Mohammad, 2011) in the T&V training model the farmers gain practical know-how through detailed demonstrations and discussions with the extension trainers and in most cases the trainings are facilitated using the local language (Anderson et al, 2006) making the model more effective in training farmers. T&V training method has been mostly used to train the farmers the model provides opportunities to farmers to learn by doing the activities they are being trained on practically by the extension agents. For instance, the T&V training model was used in India to train farmers during the process of disseminating Green Revolution technologies (Krishna et al, 2012). Participatory training approaches have also been applied by extension agents while training small scale farmers (Hagmann et al, 1999). Most recently farmer field schools (FFSs) (van den Berg and Jiggins, 2007) have also been established at different locations within the country and used to train farmers. Other extension training models which have been also been applied more recently in some countries to train farmers include ICT -based modules delivery which provides advice to farmers on-line for those farmers who can access internet connections (Birner et al, 2006). Few studies have been conducted within Thika East sub-county to explain the models that are used by the extension agents to train small scale farmers the knowledge gap this study intends to fill.

2.5 Modern agricultural technologies' information and adoption of modern agricultural technologies

The small scale farmer's choice and decision to adopt any modern agricultural technology requires different types and forms of information and knowledge about the technologies available because, for any technology adoption decision making process to be concluded, access and availability of viable information is very critical. First the farmers must appreciate that the technologies exist; second the farmer know that the technologies are beneficial if adopted and lastly the farmer must understand how to apply the knowledge about the technology effectively on his farm during the adoption process. The three stages require access to credible information to guide the adoption decision making process. Therefore, there must be a smooth flow and access to information from the available information sources to the farmers through effective and efficient communication channels. Efficient communication is facilitated by the existence of effective communication channels. Communication channels facilitate the passing of information to the farmers within a community setup with the purpose of influencing knowledge and assessment of the technologies available to the farmers during the adoption process (Toborn, 2012).

There are many different types of information sources available to farmers through which they can access information on modern agricultural technologies so as to facilitate the adoption process. Torbon (2012) notes that in a survey conducted in Punjab India among 1200 small scale farmers' households, respondents reported to use 17 different sources of information to access and obtain information on modern agricultural practices. The information sources mentioned were categorized into four groups namely; face-to-face communication sources, community social networks sources, mainstream media sources and modern ICT tools information sources. Extension officers are also an important information source as they facilitate the passage of information to farmers and thus, enabling the adoption process of new technologies by farmers. A research conducted in Western Kenyan cited extension workers as an important source of information through

which agricultural technologies information is effectively demonstrated to small scale farmers. A study on fertilizer adoption in Western Kenya also showed that intensive information provision by extension workers had a bigger effect on adoption of new systems by farmers than did information spread among peers through community social networks. Rees et al (2014) also notes in a study on agricultural knowledge and information systems undertaken by KARI and the Ministry of Agriculture (MOA) in four districts in Kenya that between 40 and 70 % of the respondents agreed that government extension workers are an important source of information to farmers. Ogola et al also found out that access to information through the extension officers in the rural context was a more effective method of reaching many farmers than other mainstream media channels. This means that the direct contact between the extension personnel and the small scale farmers greatly boosts the adoption and uptake process of the modern and emerging innovations by farmers (Ogola et al, 2010). Swanson, Bentz and Sofranko (2005) also agrees that person to person communication between the extension personnel and the small scale farmers has traditionally been the most important available form of information source to the small scale farmers.

Community social networks where information is passed through other farmers, neighbors, work mates and friends for instance, from one farmer who is more knowledgeable about some farming practices to other farmers who are less knowledgeable and exposed on the same practices is another important information source on new technologies to small scale farmers at the community level. Studies on technologies adoption in other sectors also show that individuals learn from others within the existing community social networks (Toborn, 2011). The effectiveness of the social networks as information sources depends on the size of the given networks for instance, learning from others sometimes can result in less rapid spread of technologies when the social networks are small or if the benefits of the technologies being passed are hard to observe. Examples of technologies which may be transferred slowly when the social networks are smaller include; technologies for slow growing crops that take many seasons to mature or technologies that require considerable customization for a farmer's particular growing conditions. Modern technologies are spread faster when communicated in wider and bigger social networks because they involve many people.

Mass media through mainstream communication channels for example; Radios and Television sets are other sources of information and communication channels available to small-scale farmers for obtaining information and knowledge about the existing modern agricultural practices. Mass media is more effective in creating awareness because with the advent of modern ICT tools mass media channels distribute their contents digitally in local dialects (Toborn, 2011).

Social-economic factors like age, educational levels, farm size do influence what kind of information sources farmers' will and access and rely on. For instance, higher educational levels coupled with improved economic standards in many countries, has made farmers to veer more towards modern information channels for instance; computers, mobiles phones and the internet. Rich and more educated farmers tend to have greater accessibility to diverse information sources compared to smallholder subsistence farmers who depend on a fewer sources (Toborn, 2011). Access to information through modern ICT sources by farmers is also challenged by low literacy levels and limited access to the internet connections in most parts of the developing countries including Kenya.

2.6 Agricultural research activities and adoption of modern agricultural technologies

Agricultural research activities include all the agricultural scientific processes and procedures whose sole aim is to produce new agricultural technologies, practices, services and products to facilitate improved agricultural production among farmers and those in the agricultural sector. Agricultural research activities in Kenya and elsewhere in the world are mainly undertaken by government funded agricultural research centers and institutions. Other private registered companies also undertake and facilitate some agricultural research activities in the country. The major agricultural research centers in Kenya include; Kenya agricultural research institute (KARI), Kenya seed company, other private agricultural research companies and the University agricultural research centers among others. Kenya Agricultural Research Institute (KARI) centers are the main agricultural research government funded institutions that carry out agricultural research in

Kenya. The KARI centers develops and disseminates modern agricultural technologies to farmers thus, enhancing agricultural farm productivity, promoting the post- harvest value of horticultural and livestock products by reducing post-harvest losses, while contributing to the environment conservation through the promotion of sustainable utilization of the available limited agricultural resources. KARI and other agricultural research centers develop agricultural technologies which promotes efficient utilization of the available limited agricultural resources. KARI has 29 research centers spread throughout the county, KARI Thika is one of the 29 research centers located within Thika East- Sub County. All the 29 centers are situated at different geographical locations within the county and each center is supposed to undertake agricultural research and generate agricultural technologies and products best suited to the ecological and environmental conditions within that given region where it's located. The location of the KARI centers at different locations within the county was supposed to facilitate easy access of the different centers and the agricultural research products they generate to farmers. Access to the ongoing agricultural research activities and the developed research products from agricultural research centers spread throughout the country by farmers is critical in the modern agricultural technology adoption process because the farmers cannot adopt technologies minus first accessing them upon their dissemination. Many agricultural technologies and products have been disseminated from most KARI centers for example TC bananas, Kahangi, Muthee and Chege (2004) in a research undertaken within 12 districts of Central and Eastern provinces found out that; access and adoption of TC banana technology will be of great agricultural importance to the county because it will ensure high banana productivity to meet the high food demands being experienced in the country. In Thika East sub-county the technology has been developed and disseminated by KARI centers and Jomo Kenyatta University of Agriculture and Technology. KARI Thika and other centers have also developed a number of other modern agricultural technologies among them the post-harvesting handling technology for TC bananas the technology is made up of a plywood structure that has a number of banana ripening chambers that uses high yielding ethylene gas from other fruits for instance; purple passion and avocados to initiate TC banana ripening fully and on schedule thus reducing high post-harvest losses experienced by most banana farmers using the

conventional banana ripening systems (Chege 2001). Kahangi, Muthee and Chege (2004) found out that this technology has been adopted by some small scale farmers in some parts of Central and Eastern provinces.

More than 50 registered seed companies are operating in Kenya they companies undertake research, production, processing and marketing of hybrid quality certified seeds, two private seed companies are located within Thika East sub-county but, Mwangi (2013) notes that the access of the seed companies and their products by the farmers still remains low because most small scale farmers prefers to use traditional seed over scientifically developed seeds. KARI research centers also have a seed breeding unit the unit provides quality seeds and other planting materials for those crops which are important for food security in the country especially in the arid and semi-arid areas in the country, the scientific seed producing unit has implemented a maize technology development Programme which has supplied germ- plasm to produce 80% of quality maize seeds for farmers in the main maize growing areas including Thika East sub-county (Mwangi, 2013). Irish potatoes certified seeds have also been developed and disseminated to farmers by most the KARI research centers. KARI Thika also has a horticultural seed research section which has scientifically produced hybrid seed for most exotic vegetables examples of the seeds that have been developed and disseminated include Artificial Insemination is also another modern agricultural technology that has been developed and disseminated by the livestock research centers across the country including KARI Thika through their ongoing intensive agricultural research activities to cattle rearing farmers in Kenya. Kinyanjui (2012) also notes that A.I which is scientifically developed in most livestock research centers across the country to be an alternative to the traditional natural mating method. A.I gives farmers that have adopted it the high possibility of gaining better cattle genetic improvements created elsewhere. However, this technology is unknown to most small scale farmers and as Kinyanjui (2012) found out in a study undertaken within Kakuzi division of Muranga County very few livestock farmers have accessed and practiced the technology but no conclusive studies are available on why this product of agricultural research has been adopted at a very slow rate.

Amiran Kenya limited an agricultural engineering company in Kenya undertaking agricultural research and producing modern farming technologies has greatly facilitated access to greenhouse farming technology and other modern irrigation technologies to small scale farmers. Through its agricultural research activities it has developed and disseminated a Greenhouse Kit to small scale farmers the greenhouse kit is relatively less costly it also gives the adopters complete greenhouse farming solutions since, it enables them to access other modern agricultural inputs for instance hybrid seeds and other agrochemicals; pesticides, fungicides and foliar feeds which are supplied along with the kit's installation (Solomon, 2012). On adoption the farmers are also given intensive on-farm training and support from Amiran agronomists' on all the greenhouse structure operations. The kit is also fully installed with complete drip irrigation systems together with other operational chemigation and fertigation units making it more efficient for crop growing by farmers (Solomon, 2013).

Agricultural genetic engineering (GE) is at the research level in most African countries including Kenya and Uganda. In Kenya on-going agricultural genetic engineering research activities in crop farming being undertaken by most KARI centers includes development of: virus resistant sweet potatoes, maize resistant to storage pests, and bio-fortified sorghum. Solomon (2013) also notes that most of GE agricultural research activities and the resultants output products are still at the laboratory level while a few field testing have been conducted with maize, cotton and sweet and Irish potatoes in some parts of the country and a few selected small scale farmers have taken up and adopted the GE research products which have been given for field testing by the research centers generating them but, no much conclusive studies or literature are available to show how access and availability of this GE technologies which are at the field testing stage influence the adoption of modern agricultural technologies in Thika East sub-county the knowledge gap this study aims to fill.

2.7 Theoretical Framework

The research study was based on; the Innovations Adoption Decision Model, the Diffusion of innovations (DOI) model and the adopters categories concept.

2.7.1 Innovations Adoption Decision Model

The process of adoption and uptake of new innovations and technologies has been studied for more than 30 years. According to the adoption decision model; adoption of any innovation or technology is not a single act, but a process with many stages that occurs over a period of time (Rogers, 2003). In the theory Rogers explains that potential adopters go through five stages when interacting and experiencing with new technologies that they may be willing and planning to adopt. The first stage being the “Knowledge stage” where the potential adopters searches for more information about the technologies and gains more and deeper understanding of what the technology is all about and how it works. The second stage is “Persuasion” in which case potential adopters forms impressions and mental interpretations and pictures about the innovations after attaining information about the technology and how it operates. In the third, “Decision stage”, the innovation is actually taken- up or rejected by the adopters the stage involves clear decision making on all the mental interpretations created deciding on which parts of the technology to adopt. In the fourth “Implementation stage”, actual implementation of the technologies occurs the innovation are actually applied and practiced by the adopter, implementation also involves the actual steps of resources allocation to the adoption process. In the fifth, “Confirmation stage”, the adopter seeks further information on the innovations he has implemented he reviews the information further and either decides to continue or discontinue the use of the technology, the stage involves weighing the actual benefits attained from the adopted technology and all the incurred costs for its adoption upon weighing the actual benefits and all the incurred cost the adopter will either continue or discontinue the use of any given technology. Much research from several disciplines for instance in agriculture, political science, public health, communications, history, economics, technology, and education has used the model as a framework to study technology diffusion and adoption in those disciplines (Stuart, 2000). For this study it was conceptualized that the small scale farmers go through the five stages when exposed with any new innovation before adopting that modern agricultural technology in their farm. The small scale farmers must first access information about the technologies they intend to adopt on obtaining the crucial information they must think through the information in the second stage before deciding on whether to adopt or not adopt the

modern technology in question in the third stage, after which they will actually implement the technology on their farms in the fourth stage finally in the last fifty stage on adoption they will further review the benefits and disadvantages of the adopted technologies before either deciding to adopt the technology further or suspend its further adoption in the coming cropping seasons.

2.7.2 Diffusion of innovations (DOI) model and adopters categories concepts

The DOI model has been used to explain why, how, and at what speed new innovations and technologies available are communicated and spread through the existing social systems, operating at personal, firm or company level. The theory explains the processes through which modern technologies are spread and diffused through the community; the process involves communication of the technologies through the existing communication channels over time within any given social systems (Rogers, 2003). Individuals to whom the technologies are spread possess different degrees of willingness to adopt and practice new innovations that are spread to them and for any given modern technology, there will be a certain percentage of community members who will be the first to adopt the new innovations when they are introduced while, others will either follow slowly to adopt the same technology or not adopt it at all in the long run. According to Rogers, there is usually a normal distribution of the various adopters' categories and when plotted in a graph, the various adopters categories form a bell-shaped curve. The curve obtained is divided into five sections that represent the adopters' categories. The "Innovators" make up the first zone consisting of a group of members within any population who will readily adopt new innovations the first time they are disseminated from the research centers the innovators make up about 2.5% of any population. The "Early Adopters" zone makes up approximately 13.5% of any population it has those community members who will follow the innovators in adopting new technologies as the second group. Most people will fall into either in the Early Majority adopter's zone or the Late Majority adopter's zone, the two zones will consist of (34%) members of any typical population they consist of community members who will adopt technologies way after the innovators and the early adopters. The "Laggards" zone is the last of a group of adopters that has those community members who will resist new innovations until the bitter end they will be the last group of people in any community to adopt new innovations; laggards comprise

about 16% of any population members. The concept of adopter categories was important for this study because it showed that all new technologies disseminated for adoption to farmers will go through a timed natural, predictable, and lengthy process influenced by different factors before being fully accepted and adopted by small scale farmers within any social setup it's a process that requires time and irrespective of which adopters category farmers belong at any given time the adoption process will still be influenced by different factors throughout the process.

2.8 Conceptual Framework

A conceptual framework is a set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentation, it also creates awareness and understanding of the situation under scrutiny and communicates the same (Kombo and Tromp, 2013). In this study, the independent variables were; resources, extension services, modern agricultural technologies' information and agricultural research activities they were broken down into indicators that were studied to provide answers to the research questions based on the four objectives. Adoption of modern agricultural technologies was the dependent it gave the desired results after the study was completed.

Independent variables

Dependent variable

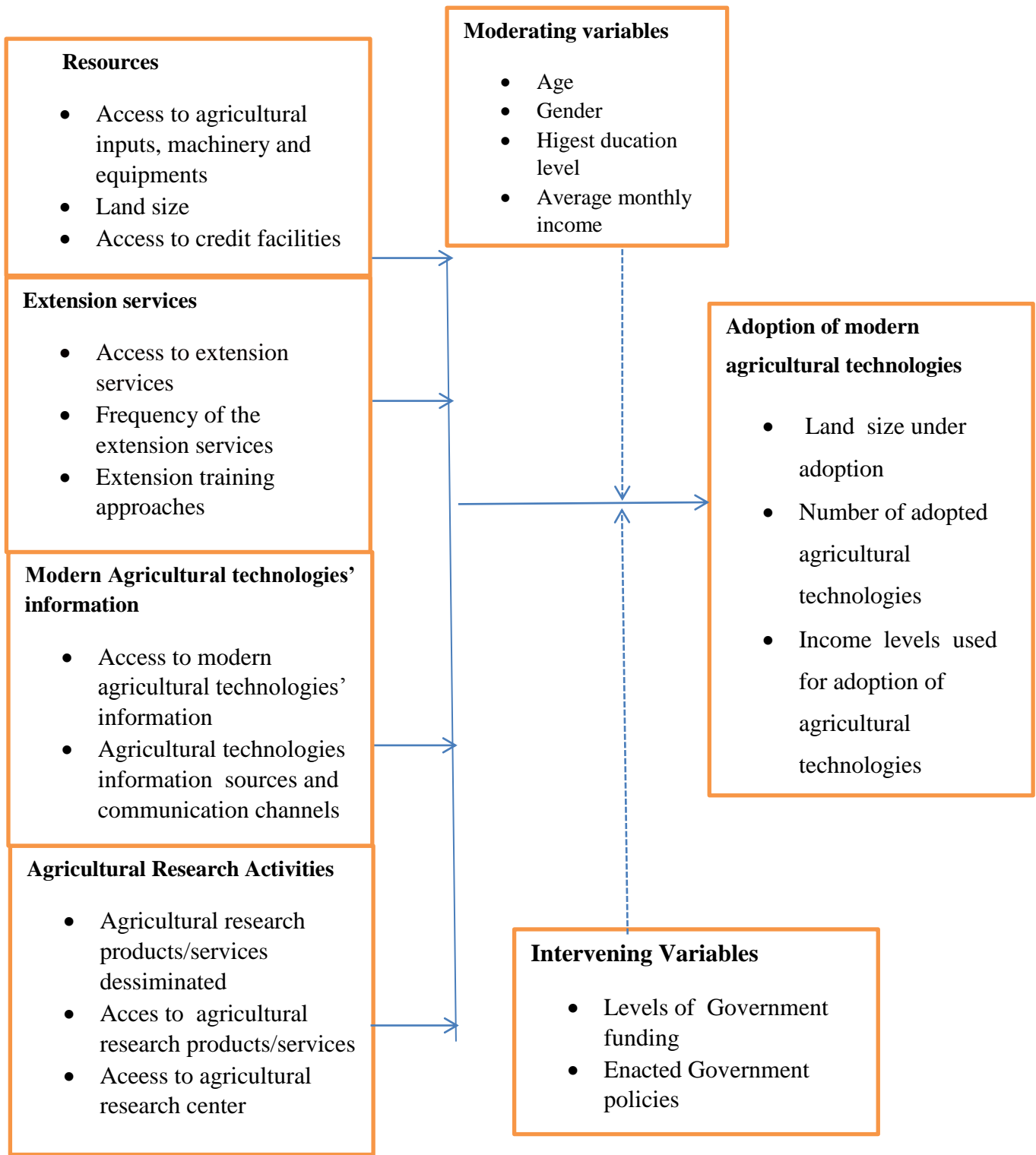


Fig. 1: Conceptual Framework

2.9 Summary of Literature review and Knowledge gaps

This section presents a summary and the identified knowledge gaps from the reviewed literature it was observed that there are knowledge gaps relating to the factors influencing the adoption of modern agricultural technologies. There seems to be limited or no study carried out in Thika East sub-county on factors influencing the adoption of modern agricultural technologies this study intends to contribute to filling the information gap. All the studies reviewed seem to be unanimous on the influence of access to various agricultural resources on the adoption of modern agricultural technologies. However little or no study have been carried out in Thika East sub-county to address the same issue.

Studies reviewed revealed a declining and low contact between the extension officers and the small scale farmers, also past studies have identified the most common training approaches and techniques applied by extension officers to train the farmers but, few studies have been conducted to establish how the low access to extension services by farmers and how the extension training techniques and approaches used influence the adoption of modern agricultural technologies. The study therefore intends to establish how low access to extension services and the training methods used influence the adoption of modern agricultural technologies.

Most studies reviewed agreed to the fact that most small scale farmers access information on modern agricultural technologies but no literature exists on how access to information by small scale farmers influence the adoption of modern agricultural technologies the knowledge gap this study intends to fill

Most reviewed literature identified that many modern agricultural technologies that have disseminated from the research centers have been adopted at very slow rates in most parts of the country including Thika East sub-county where this study was delimited but no conclusive studies have been done on the factors influencing the rates of adoption the available modern agricultural technologies the knowledge gap this study intends to fill.

Table: 2.1 Knowledge Gaps

Author(s)	Title of the study	Methodology	Findings	Identified knowledge gaps	Focus of the current study
Kinyanjui, 2012	Social-Economic factors influencing sustainability of Dairy Goat farming within Kakuzi Division Muranga County.	Quantitative methodology was used, with questionnaires being main research tools administered to; Goat farmers and extension officers	The study found out that despite the many technologies that have disseminated to livestock farmers individual adoption at the farm level remains low.	The study found out that the rates of technologies adoption by goat farmers is low but the factors influencing the adoption rates were not found out The study was delimited to only Goat farmers within Kakuzi Division, Muranga county the same results cannot be generalized to other livestock farmers within Thika East sub-county	The current study focuses on the factors that influence the adoption of modern agricultural technologies The current study will be delimited to all Livestock farmers within Thika East sub-County.
Umeghalu et al, 2012	Modern agricultural technologies adoption and constraints to adoption by Nigerians' small scale farmers	A descriptive survey design was used; the questionnaires were used to interview the small scale farmers.	The study found out that limited access to credit has negatively affected the application of modern	The study was delimited to small scale farmers in Nigeria, the same results cannot be generalized to Thika East sub-	The current study focuses on small scale farmers within Thika East sub-county.

			technologies by farmers.	county small scale farmers.	
Kahangi, Muthee and Chege, 2004	Limitations and solutions for the uptake of TC propagated banana and their marketing. Undertaken within Central, and Eastern Kenya	Quantitative survey methodology was used. Interview schedules were used to interview the research scientists and small scale farmers as the main respondents.	The study found out that a few small scale farmers have adopted Tissue culture bananas	The study never researched into the factors influencing the adoption of Tissue culture bananas by small scale farmers.	The current study focus on the factors influencing the adoption modern agricultural technologies including TC bananas
Langat et al, 2013	Drivers of Technology adoption in a subsistence economy: The case of Tissue Culture Bananas in Western Kenya.	Quantitative survey design was employed. Closed ended questionnaires were used to collect from the small scale farmers as the main respondents.	The study found out that the adoption of Tissue Culture bananas is both externally and internally limited and hindered by many factors.	The study did not discover how and to what extent the general factors (internal and external) identified influence the adoption of other modern agricultural technologies.	The current study focuses on how the specific internal and external factors influence the adoption of modern agricultural technologies.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents and describes; the research design which was used during the research study, the target population for the study, the sample size and the sampling techniques that were used. Data collection procedures, research instruments and data analysis techniques that were used are also explained.

3.2 Research Design

A research design is an organization of factors that guides data collection and analysis. It is the guiding framework within which any research is conducted; it constitutes the blueprint for collection, measurement and analysis of data (Kothari, 2004). For this study a cross-sectional descriptive survey design was used because the data collected was mainly concerned with the respondents' opinions and attitudes while practicing agricultural activities on their farms while in the process adopting modern farming technologies as small scale farmers, or either as extension officers and research scientists facilitating the modern technology adoption process. Descriptive survey highlights an accurate quantitative or numeric description and depiction of the respondents', opinion, beliefs and abilities (Cooper and Schindler, 2008). This type of survey assisted in the elimination of any kind bias that may have occurred during data collection. The purpose of descriptive research is to determine and report the way things are happening thus helping in establishing the current status of the population under study (Mugenda and Mugenda, 2004). Descriptive survey is used in preliminary studies to enable researchers gather information and interpret data for clarification. This design was chosen because it ensured reliability of the data collected for interpretation.

3.3 Target population

The target population for this study consisted; 200 small scale farmers drawn from the three villages namely; Nanga, Ithanga and Magogoni within Thika East sub-county as show in Table 3.1. The three villages were chosen because of their unique characteristic of being the main rural areas in Thika East sub-county, the most part of the Sub- County

being of an urban setting. Most of the residents within these three selected villages practice small scale farming; growing different types of crops and rearing different types of livestock on their pieces of land some of them have also adopted modern agricultural technologies and since, these residents are of different social and economic backgrounds the sample size which was selected from this target population was thus heterogeneous and perfect for the research study. The study also targeted 10 Research scientists from KARI Thika and 8 agricultural extension officers within the sub-county. A total of 218 respondents were targeted for the entire study as shown in Table 3.1.

Table 3.1 Target population for the two categories of respondents

Categories	Target Population
	Small scale farmers
Nanga Village	47
Magogoni Village	68
Ithanga Village	85
	Other respondents
KARI Thika research Scientists	10
Thika East Sub- county Extension Officers	8
Total	218

3.4 Sample Size and Sampling Techniques

The sample size for the small scale farmers in the three villages was chosen using Krejcie and Morgan Table (1970), which determines sample size based on the formulae:

$$S = \frac{X^2 \cdot N \cdot P(1 - P)}{d^2(N - 1) + X^2 P(1 - P)}$$

Where:

S = required sample size

X^2 = the table value of chi-square for degree of freedom at the desired confidence level (3.841)

N = the population

P = the population proportion (assumed to be .50 since this would provide the maximum sample size)

d = the degree of accuracy expressed as a proportion (.50)

Based on the target population of 200 small scale farmers, a sample size of 127 small scale farmers was drawn (Krejcie and Morgan Table, 1970).

The researcher used simple random probability sampling technique to draw the sample population from the target population of small scale farmers. During simple random sampling each small scale farmer from the three village's target population was chosen randomly entirely by chance, such that each small scale farmer had the same probability (or chance) of being selected into the sample population. The sampling was done by assigning all the 200 targeted small scale farmers numbers (from number 1 to number 200) the table of random numbers was then used to select the 127 farmers to form the sample population. All the 18 respondents belonging to the second group of respondents were sampled to participate in the study.

From the total sample size of 127 small scale farmers, specific sample sizes of small scale farmers for each of the three villages where the study was undertaken was obtained using the formula given below:

$$\frac{\text{Target population from each village} \times \text{Total sample size}}{\text{Total target population}}$$

Total target population

The distribution of the all members from the two categories of respondents (small scale farmers, KARI Thika research scientists and Extension officers) selected from the target population to form the sample population that was used for the study is given in Table 3.2

Table 3.2 Sample size for the two categories of respondents

Respondents	Target population	Sample population	
	Small-scale farmers		
Nanga village	47	(47x127)/200	30
Magogoni village	68	(68x127)/200	43
Ithanga village	85	(85x127)/200	54
	2nd group of respondents		
KARI Thika scientists	10		10
Extension officers	8		8
Totals	218		145

3.5 Research Instruments

Data was collected from the entire respondents sampled through the administration of structured questionnaires. The Questionnaires were used to collect primary quantitative data, the questionnaire was chosen as the main tool of data collection because it has the potential of reaching a large number of respondents within a short time, questionnaires permits the researcher to collect quantifiable data pertinent to the study relatively quickly (Gay, Mills and Airasian, 2009). Questionnaires also gave the respondents adequate time to respond to the questions, they also offered a sense of security (confidentiality) to the respondents; and it was an objective method since no bias resulted from the respondents' personal characteristics.

3.6 Piloting the instruments

A pilot study was conducted in Gatanga and Kabati in Muranga South sub-county as the regions exhibited the same characteristics as the sub-county under study targeting 10% of the sample population which was 13 small scale farmers. The pilot study enabled the researcher to pretest all the research instruments. Data obtained from the pilot study was used to moderate the final results from the research instruments

3.7 Validity of instruments

According to Mugenda and Mugenda (2003), validity is the accuracy and meaningfulness of inferences which are based on research results in terms of the research instrument, validity refers to the extent to which research instrument measures what it is designed to measure (Gay, 2009). Validity implies how well the measuring instruments used in the research fulfill the purpose of the study. The purpose of this study was to investigate the factors influencing the adoption of modern Agricultural technologies by small scale farmers in Thika East sub-county and KARI Thika.

To ensure validity of any instrument used the researcher measured and determined the three types of validity; content, criterion and construct. Kothari (2004) explains that content validity is the extent to which a measuring instrument provides adequate coverage of the topic of study; content validity also ensures that all the respondents understand the items on the questionnaire thus avoiding misunderstanding. Construct validity measures the extent to which results obtained from a research instrument related to a given sound theory while, criterion validity involves estimating the relationship between measures or instruments of known validity with other instruments.

To check on the content validity of the research instruments used the opinion of the project supervisor, knowledgeable peers and two experts in the subject of the study were sought. Response options were also provided for most questions in the research tools to ensure that the answers given were in line with the research questions.

3.8 Reliability of instruments

According to Mugenda and Mugenda (2003), reliability is a measure of the degree to which a research instrument yields consistent results after repeated tests when administered a number of times. It also refers to the situation where the results of a study can be reproduced under similar methodology (Joppe, 2000). The researcher measured the reliability of the questionnaires as the major research instrument used for the research study and the instruments were said to be reliable if they gave consistent results (Kothari, 2004).

To measure reliability, the researcher used split- half technique. The measure involved splitting the research instrument into two parts (odd and even numbered questions) and each of them treated as a separate measure. Statistical Program for Social Sciences (SPSS) was used to calculate reliability coefficient of the instruments (equal length spearman-Brown coefficient). The questionnaire for the small scale famers yielded a reliability coefficient of 0.8. Mugenda and Mugenda (2003) notes that, the acceptable reliability correlation coefficient should range from 0.6 to 1.0 in social sciences reliability coefficient obtained for this study was therefore accepted. The questionnaires for the pilot reliability study were administered in Gatanga, Kabati and Makuyu-Kenol in Muranga South sub-county.

3.9 Data collection procedures

An approval letter was obtained from the University of Nairobi's Extra Mural Department; a research permit was also obtained from the National Council for Science, Technology and Innovation (NACOSTI). The researcher also sought authority and approval from the administrative officers; the assistant chiefs in each of the three villages where the respondents were sampled from before field data collection was undertaken. Six research assistants were recruited two covering each of the village; they were trained and assisted the researcher in the data collection process. An approval was also sought from the heads of departments and those in charge of the two government organizations; KARI Thika center and Thika East sub- county Agricultural office before the data collection process was undertaken.

3.10 Data Analyzing Techniques

Collected data from closed ended questions in the questionnaires was coded by assigning numerical values to differentiate the categories then double entered into a computer database designed using Micro-soft Access application. Data cleaning and validation was performed in order to achieve a clean data set that will then be exported into statistical package for social sciences (SPSSver.22). The data was then analyzed using statistical package for social sciences (SPSS) version 22. Quantitative data was presented using frequency tables while, Karl Pearson product moment correlation analysis was employed to determine the direction and strength of relationship between the some variables.

3.11 Ethical consideration

In this study the researcher ensured that the study participants were protected by keeping the information given confidential, the researcher also observed the principle of anonymity the participants never indicated their names on questionnaires and other tool of research. The principle of voluntary consent where participants willingly participated in the study was also highly upheld to avoid causing any harm to the participants.

Table 3.3: Operationalization of variables

Objectives	Variables	Indicators	Measurement	Measurement Scale	Tools of Data collection	Techniques of data analysis
To determine the level of modern agricultural technologies adoption by small scale farmers in Thika East sub-county	Adoption of modern agricultural technologies	Land size under adoption	Hectares of land used for adoption	Ordinal	Questionnaire	Descriptive Statistics-frequency and percentage
		Adopted technologies	Number of adopted technologies in the farm	Ordinal	Questionnaire	Descriptive-frequency and percentage Statistics
		Level of income used for adoption of agricultural technologies	Average amount of income used for adoption in one year	Ordinal	Questionnaire	Descriptive Statistics-frequency and percentage
To establish the influence of access to resources on the adoption of modern Agricultural technologies by small scale farmers in Thika East sub- county.	Resources	Land size	Hectares of land used for agricultural activities	Ordinal	Questionnaire	Descriptive Statistics-frequency and percentage
		Access to credit facilities	Average amount credit accessed in the last one year	Ordinal	Questionnaire	Descriptive Statistics-frequency and percentage
		Access to agricultural inputs	Type of inputs, machinery and equipments accessed	Nominal		
To determine the influence of access to extension services on the adoption of modern	Extension services	Frequency of extension services	Number of extension officers visits	Ordinal	Questionnaire and interview schedule	Descriptive Statistics-frequency and tables and Pearson's correlation

Agricultural technologies by small scale farmers in Thika East sub-county						analysis
		Access to extension services	Distance from extension offices. Number of extension visits.	Ordinal	Questionnaire and interview schedule	Descriptive Statistics- frequency and percentage
To determine the influence of access to agricultural technologies' information on the adoption of modern Agricultural technologies by small scale farmers in Thika East sub-county	Modern Agricultural technologies' information	Access to agricultural technologies information	Sources of information available to farmers	Nominal	Questionnaire and interview schedule	Descriptive Statistics
		Agricultural technologies information sources and communication channels	Sources of information available	Nominal	Questionnaire and interview schedule	Descriptive Statistics
To establish the influence of agricultural research activities on the adoption of modern Agricultural technologies by small scale farmers in Thika East sub-county	Agricultural research activities	Access to agricultural research activities	Number of agricultural research activities disseminated to farmers Distance covered to access or provide agricultural research services	Ordinal	Questionnaire and interview schedule	Descriptive Statistics
		Access of agricultural research products	Number of research product accessed	Ordinal	Questionnaire	Descriptive Statistics- frequency and percentage
		Agricultural research centers accessed	Number of research centers accessed	Ordinal	Questionnaire	Descriptive Statistics

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION OF FINDINGS

4.1 Introduction

This chapter details data analysis, presentation, interpretation and discussion of the findings. The results are presented based on the objectives of the study which aimed at examining the factors influencing the adoption of modern agricultural technologies by small scale farmers the study focused on the small scale within Thika East sub-county. The data was collected from the small scale farmers from the 3 villages (Ithanga, Nanga and Kasioni) within Thika East sub-county, Research scientist from KARI Thika and Extension officers providing extension services within the sub-county using using structured questionnaires. The collected data was analysed using frequencies and percentages together with Karl Pearson product moment correlation analysis then presented using frequency and percentages tables.

4.2 Research tools Return Rate

Return rates of research tools administered to the three categories of respondents are given in Table 4.1.

Table 4.1 Research tools Return Rates

Tools	Tools delivered	Tools returned	Percentage of tools returned
Small scale farmers' Questionnaires			
Nanga Village	30	27	90
Magogoni Village	43	38	88
Ithanga Village	54	45	83
KARI Research scientist Questionnaires	10	10	100
Extension officers' Questionnaires	08	08	100
Total	145	128	

On average all the research tools yielded a return rate of above 80%, a return rate below 80% bias is likely to occur and a response rate below 60% is 'barely acceptable' (peninsula Research and Development support Unit, n.d). This means that the return rate for all the administered instruments was acceptable because it was above 80%. It was possible to obtain a high level of return rates by personally presenting most of the research tools to the respondents and where this was not possible the researcher and his assistants made follow ups.

4.3 Demographic information of the respondents

This section describes the demographic information of the small scale farmers; gender, age, higher educational levels attained and average monthly income levels subjected to descriptive statistics analysis.

4.3.1 Respondent's gender

Data collected on the small scale farmer's gender was analyzed; the results obtained are tabulated in Table 4.2.

Table 4.2 Small scale farmers by gender

Gender	Frequency	Percentage
Male	44	40
Female	66	60
Total	110	100.0

The results show that about 66% of the respondents were female while 44% were male. Since all respondents were small scale farmers this implies the majority of the small scale farmers are women. This can be attributed to the fact that most men are engaged in providing casual labour in the nearby plantations farms of Delmonte Kenya Nut and Kakuzi limited companies leaving the women fork to take care of the farming activities. Most small scale respondents were female this concurs with the study carried out by the ministry of Agriculture; Livestock Development in 2012 which found out that Kenya had 3 million small holder farmers, 69% of whom are women (Ngari, 2007). Ogola et al also found out that most women were engaged in agricultural activities on the family's land as men went off- farm work (Ogola et al, 2014).

Data collected on the extension officers and research scientists' gender was analyzed; the results obtained show that more respondents were male at 72.2% while 27.2% were female the results were similar with what Kinyanjui (2012) obtained where 75% of the extension officers who responded male.

4.3.2 Respondents' age groups

Data collected on the small scale farmers' age groups was analyzed; the results obtained are tabulated in Table 4.3.

Table 4.3 Respondents by age groups

Age group (years)	Frequency	Percentage
20-30	10	9
31-40	33	30
41-50	50	45.5
51-60	12	11
61 and above	5	4.5
Total	110	100.0

The results obtained shows that over 61% of the small scale farmers who responded were aged above 40 years. Only 39 % of the small scale farmers were youths (35years and below). This implies that in Thika East sub-county most youths don't engage in any agricultural activities since most youths tend to migrate to the nearby urban centers; Thika and Nairobi to seek for employment opportunities rather than engage in agricultural activities most youths in the sub-county would rather be employed as casual labourers in the neighboring plantation farms than going into their own farming. Most of the youths also don't own land and have low access to financial resources, land is owned mostly by their parents therefore lack of adequate land and financial resources to the youths has made them shun away from agricultural activities. The findings obtained were also in consistent with Ngari (2007) who observed that young people may be receptive to new ideas and innovations in agriculture but may not perceive farming and thus the adoption of modern agricultural technologies in farming as an important economic activity to undertake. Kipserem et al (2011) also observed that the average age of farmers in Keiyo valley was 39 years and thus he concluded that the youth mostly tend to shun agricultural activities. The age of the small scale farmer plays critical role in the adoption

of improved agricultural technology (Mohammad, 2012). Mohammad (2012) in his study also found out that young generation are more motivated towards new technology adoption as compared to old but the findings obtained in this study are contrary to that observation.

Data collected on the extension officers and research scientists' age groups was analyzed; the results obtained show that more respondents were between the ages of 41-50 years at 55.5%, the age group of between 51-60 years had 27.8% of the respondents while the age group of 31-40 % had 16.7% of the respondents.

4.3.3 Respondents' highest education levels

Data collected on the small scale farmers' highest education levels was analyzed; the results obtained are tabulated in Table 4.4.

Table 4.4 Small scale farmers by highest education level

Education Level	Frequency	Percentage
Never attended school	8	7
Primary	41	37
Secondary	47	43
College/ University	13	12
Agricultural technical training course	1	1
Total	110	100

The results obtained show that 110 respondents indicated their highest education level attained. The results agree with Ogola et al 2010 who studied educational characteristics of small scale farmers in Nyanza, Coast and Rift Valley provinces and concluded that mostly those farmers involved in farming activities were lowly educated at 51.9% having secondary school education and below, 28.7% are also illiterate (Ogola et al, 2010). According to the 2009 census report 10% of Thika East sub-county residents have never attended school, out of which most are women. Education is important for effective

transfer of knowledge and implementation of knowledge gained through training. The low level of education characteristics of the farmers means that searching for technical information from other sources like the internet and through mobile phones is impossible considering the low level of contact between the farmers and extension officers. There is also tendency for improved adoption of new technologies like greenhouse farming for farmers with higher levels of education. The result obtained emphasizes the point that education plays an important role in the adoption of improved agricultural technology when most citizens in a country are literate; they will be more efficient, knowledgeable and capable of adopting new innovations (Mohammad, 2012).

Data collected on the extension officers and research scientists' highest education levels was analyzed; the results obtained shows that 78% of the respondents have attained a Bachelors degree as their highest education level while, 11% have attained Diploma while 11% have also attained Masters Degrees as their highest education level. Similar findings were obtained by Kinyanju (2012) who found out that most extension providers were trained above at least Diploma level and they therefore possess relevant skills and knowledge which they can impart to the farmers.

4.3.4 Small scale farmers' average monthly income

Data collected on the small scale farmers' average monthly income was analyzed; the results obtained are tabulated in Table 4.5.

Table 4.5 Small scale farmers' average monthly income

Monthly income (Ksh)	Frequency	Percentage
Less than 3,000	10	9
3001 to 5000	09	8
5001 to 10000	21	19
10,001 to 15,000	30	27
15,001 to 20,000	26	23
Over 20,001	15	14

The study found out that most small scale farmers are low income earners because only 14% of the respondents earn an average monthly income of Ksh. 20,001 and above. All the other respondents had an average monthly income of less than Ksh.20, 000. The same results were obtained by Kinyanjui, (2012) who also found out in his study that most small scale farmers in Kakuzi Division were low income earners. This is probably due to the fact that the area is frequently stricken by prolonged dry periods and thus farming enterprises are usually affected by long dry periods leading to low farming income because the study found out that most of the small scale farmers representing 44% of the interviewed small scale farmers depend on farming income. The low levels of education also means that most of the residents can only work as casual labourers in the nearby plantations farms namely; Delmonte , Kakuzi and Kenya Nut limited companies where they are lowly paid on average the casual labourers in the three companies get paid a monthly salary of less than Ksh. 10,000.

The extension officers and KARI Thika research scientists who took part in the study were also asked in their opinion to rate the level of small scale farmers' monthly income 66.7% of them said the levels are very low while 33.3% of them said the income levels of small scale farmers was low. They were further asked in their opinion to indicate whether monthly small scale farmers income levels influence the adoption of modern agricultural technologies 88.9% of them said yes while 11.1% of them said no, those who said yes agreed with the observation that levels of farmers monthly income determines the portion of financial resources set aside or invested in the purchase of inputs required for the adoption of modern agricultural technologies.

4.4 Influence of Resources on the adoption of modern agricultural technologies

Data collected on the different resource factors was analyzed to determine their influence on the adoption of modern agricultural technologies by small scale farmers. The three resource factors considered were; access to credit and loans, land size and agricultural inputs, modern equipments and machineries.

4.4.1 Access to credit and Loan facilities

Data collected on access to credit and loans facilities by small scale farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers.

Table 4.6 Access to credit and Loan facilities

Response	Frequency	Percentage
Yes	10	9
No	100	91
Total	110	100

Table 4.6 represents the small scale farmers' responses on access to credit and loan facilities for their agricultural practices and thus the adoption of modern agricultural technologies. Out of the 110 small scale farmers who were interviewed 91% of them said that they have never accessed credit facilities for their agricultural activities and thus adoption of modern agricultural technologies its only 9% of the respondents who agreed to have accessed credit facilities for their agricultural activities.

Table 4.7 Ratings of the levels of access to credit.

Rating of the level of access to credit	Frequency	Percentage
Very high	0	0
High	0	0
Low	7	38.9
Very Low	11	61.1
Total	18	100.0

Table 4.7 represents the research scientist and extension officers' responses on the ratings of the levels of access to credit and loan facilities by farmers for their agricultural practices and thus the adoption of modern agricultural technologies. Out of the 18

respondents who responded 61.1% of them rated access to loans by small scale farmers as very low while 38.9% responded rated access to loans as low. They were also asked in their opinion if access to loan facilities influence adoption of modern agricultural technologies 100% of them agreed that access to loans and other credit facilities determines which technologies are adopted by the farmers because some technologies require high financial capital which can be obtained through loan facilities.

The findings show a generally low access to credit facilities among small scale farmers, inadequate access to credit facilities by small scale farmers limits the financial resources available for the of purchase the inputs, equipments and machinery required for the adoption of modern agricultural technologies by farmers this has negatively impacted the adoption of modern agricultural technologies by small scale farmers. The findings were in agreement with what Wanyama et al (2013) noted that limited access to credit inhibits farmers' investment in agricultural technologies and innovations.

4.4.2 Challenges limiting the access to loans by farmers

Data collected on the challenges limiting the access to credit and loans facilities by the small scale farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers.

Table 4.8 Responses on challenges limiting access to loans and credit facilities

Barriers to access of credit and loans	Frequency	Percentage
Lack of collateral (security)	37	26
Inadequate access to information on credit facilities	50	35
Inadequate banking services	35	25
High interest rates	17	12
Others	3	2
Total	142	100

Table 4.8 gives the challenges limiting the access to loans and credit facilities as given by small scale farmers who responded. Inadequate access to information ranked first as the

main reason for lack of access to credit facilities at 35%. The other reason the study found out why the small scale farmers have poor access to credit facilities was lack of collateral and security to secure the loans as required by most financial institutions extending the loans at 26% of the small scale farmers' responses, lack this can be explained by other study findings in which case 56% of the respondents said they don't have title deeds for their pieces of land; they only have allotment letters to proof ownership.

The extension officers and KARI Thika research scientist who responded were also asked to give the reasons why access of credit and loan facilities by small scale farmers is low or very low all of them agreed that the main reason for low access to credit by small farmers was due to lack of collateral, 50.2% of the other responses mentioned inadequate and poor banking services while 20% of the responses blamed high interest rates.

Inadequate access to information ranked first as the main reason for the low access to credit facilities at 35% among the small scale farmers who responded this is because most of the existing large commercial banks rarely venture into the outlying rural areas to educate the farmers on credit facilities available to them. Lack of collateral which was mentioned by most of extension officers and research scientists and 26% of the small scale responses as another reason for the low access to loan facilities was also a factor mentioned by farmers in a survey conducted in Nigeria where Umeghalu (2012) reported that financial institutions don't give loans to a majority of small scale farmers who don't provide collateral and that was a major factor hindering adoption of modern technologies by small scale farmers ultimately due to lack of funds to purchase other complementary inputs required. The study also that established that most small scale farmers interviewed were female. Land title deeds are usually in the name of their husbands therefore the women cannot use them as collateral to secure loans. Inadequate access to banking services was mentioned by 25% of small scale farmers and 50.2 % of extension officers and KARI Thika research scientist who responded as another reason low access to credit facilities this may be attributed to the distances that the farmers have to cover to access accessible banking services within the sub-county. No major banks have branches in the rural areas of the sub-county most bank branches found in Thika town are as far 15

kilometers from the rural villages where most small scale farmers reside. Inadequate access to banking services may also be due to the fact that Thika East sub- county has a few banking institutions accessible to the small scale farmers for instance only Kakuzi Credit SACCO is situated at Ithanga Town. Therefore the banking facilities are inadequate to provide financial services to all small scale farmers in the sub-county. Other forms of banking services available to farmers are informal and un-regulated in nature for instance table banking and shylock which only extend smaller loans inadequate to enable farmers invest them in their agricultural activities (Kinyanjui, 2012).

4.4.3 Farmers’ total land size under agricultural activities

Data collected on the small scale farmers’ total land size under agricultural activities was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers. The results obtained are tabulated in Table 4.9.

Table 4.9 Total land size under agricultural activities

Size of land under agricultural activities	Frequency	Percentage
Less than 1 acre	47	43
Between 1 and 2 acres	33	30
Between 2.1 and 5 acres	23	21
Between 5.1 and 8 acres	5	5
Between 8.1 and 10 acres	1	0.5
Above 10 acres	1	0.5
Total	110	100.0

The responses obtained shows that only 6% of the respondents practices agricultural activities on land sized more than 5 acres, most small scale farmers who responded representing 94% said they practice agricultural activities on land of size less than 5 acres. The findings show that smaller land sizes have hindered the adoption of some modern agricultural technologies by some small scale farmers who responded for instance, farmers with land of size less than 5 acres cannot access hybrid poultry being

disseminated by Kenchic a local breeding poultry company because a proof of land ownership of size more than 5 acres is required as a key requirement before the hybrid chicks. The findings concurred with Mohammad (2012) who also noted that small and marginal landholdings were obstacles to the adoption of new farming technologies because the farmers with small land sizes will not be willing to take any risk to adopt new agricultural technologies on their farms.

4.4.4 Access to agricultural inputs, equipments and machineries by small scale farmers

Data collected on the access to agricultural inputs, equipments and machineries by small scale farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers.

Table 4.10 Access to agricultural inputs, modern equipments and machineries by small scale farmers

Response	Frequency	Percentage
Yes	12	11
No	98	89
Total	110	100

Table 4.10 represents the small scale farmers' responses on the access to the agricultural inputs, modern equipments and machineries needed for the adoption of modern agricultural technologies. Majority of the respondents at 89% agreed that they have never accessed the required input for the adoption of modern agricultural technologies, only 11% of the respondents said they have accessed the necessary inputs needed for the adoption of modern agricultural technologies.

Table 4.11 Ratings of the level of availability of agricultural inputs to farmers

Rating of the levels of inputs availability	Frequency	Percentage
Rarely available	10	55.6
Available sometimes	8	44.4
Always available	0	0
Not available at all	0	0
Total	18	100.0

Table 4.11 represents the opinion of the extension officers and research scientist who responded and rated the availability of agricultural inputs, modern equipments and machineries required for the adoption of modern agricultural technologies by small scale farmers. The results obtained shows that 55.6% agreed that inputs are rarely available while 44.9% of them responded that the inputs are available to farmers sometimes.

Inadequate access of some critical inputs and other requirements like electricity or some reliable source of power affects the access to other farming inputs for instance irrigation water since electricity or any other reliable source of power is required for the pumping of water from the accessible water sources. Most small scale farmers who responded said they depend on irrigation for their farming activities. Most interviewed small scale farmers said they don't access any reliable sources of water but they depend on rain for their agricultural it's thus a challenge for most of them to adopt those technologies that require reliable access to water for instance greenhouse farming and drip irrigation. Most parts of Thika East sub-county are semi-arid regions that experiences only two short rain seasons (April-May and October-December) most part of the year experiencing prolonged dry spells. Over dependence on rain for agricultural activities has greatly hindered the adoption of some modern agricultural technologies since rain is very

unreliable. Thika River was also mentioned by 45% of the responding small scale farmers as their main source of irrigation water for their agricultural activities but the River source is not reliable and accessible to most small scale farmers because those who access it must invest in a pumping Honda pump and fuel investing in the two requires financial resources which as this study discovered are limited and not accessible to most small scale farmers. The River is also used by other agricultural companies in the region as a source of water for irrigating their farms this creates constant competition for the scarce resource, forcing those government organization in-charge of river water uses to restrict the use of Thika river water by farmers for irrigation purposes affecting the farmers' agricultural activities and thus the adoption of modern agricultural technologies.

Table 4.12 Access to agricultural inputs by monthly income

Average monthly income (Ksh)	Frequency	Percentage	Total
Less than 3,000	0	0	10
3001 to 5000	0	0	9
5001 to 10,000	0	0	21
10,001 to 15,000	0	0	30
15,0001 to 20,000	1	1	26
Above 20,000	11	10	15
Missing	98	89	0
Total	110	100.0	110

Table 4.12 represents those small scale farmers who agreed to access agricultural inputs, modern machinery and equipments by their monthly income. The results obtained shows that it's only those small scale farmers who earn an average monthly income above Ksh 20,001 who access the necessary required inputs this is because most inputs and equipments are costly therefore high capital investment is required for their purchase.

Table 4. 13 Monthly income and access to agricultural inputs Correlation

		Average monthly income	Access to Agricultural inputs
Average monthly income	Pearson Correlation Sig. (2- tailed)	1	0.59* 0.21
	N	110	110
Access to agricultural inputs	Pearson Correlation Sig. (2-tailed)	0.59* 0.21	
	N	110	110

***Correlation significant at 0.01 level (2-tailed)**

Table 4.13 represents a Karl Pearson correlation analysis between average monthly income and access to agricultural inputs the results shows a strong positive relationship of a correlation coefficient of 0.6 between average monthly income levels and access to agricultural inputs. Farmers with higher income levels will access more agricultural inputs than farmer with low income levels.

4.4.4 Challenges limiting the access to agricultural inputs, equipments and machineries by small scale farmers

Data collected on the challenges limiting the access to agricultural inputs, equipments and machineries was analyzed to determine its influence on the adoption of modern

agricultural technologies by small scale farmers. The obtained results are tabulated in Table 4.14.

Table 4.14 Responses on the challenges limiting the access to agricultural inputs

Challenges to access of agricultural inputs	Frequency	Percentage
Stock list selling the inputs are located far	21	11
Inadequate financial resources	73	38
High input prices thus they are un-affordable	89	48
Minimal government support	7	3
Total	190	100

Majority of the responses obtained at 48% mentioned high input prices as the main reason for low access to inputs, 38% of the responses mentioned inadequate financial resources as the second reason while, 11% of the responses favored stock list selling the inputs being located far as minimal government support was mentioned by 3% of the farmers who were interviewed. High input prices and inadequate financial resources were each given by 50% of the responses obtained from the research scientist and extension officers who responded. Other responses obtained from the extension officers and research scientists shows that most inputs are not manufactured locally but must be imported. In Nigeria for instance, Umeghalu et al (2012) also found out the same situation where most of the available modern agro-machines and equipments are imported from western countries which makes them more expensive and thus most small scale farmers can't afford them.

4.5 Influence of Extension services on the adoption of modern agricultural technologies

Data collected on extension services was analyzed to determine how provision and access of extension services influence the adoption of modern agricultural technologies by small scale farmers.

4.5.1 Access to Extension services

Data collected on access to extension services by small scale farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers.

Table 4.15 Access to extension services on modern agricultural technologies

Access to extension services	Frequency	Percentage
Yes	29	26.4
No	81	73.6
Total	110	100

Table 4.15 represents the small scale farmers responses on access to extension services provided on modern agricultural technologies. The results obtained shows that most small scale farmers have not accessed extension services on modern agricultural technologies for instance, 73.6% of the respondents said they have never accessed extension services on modern agricultural technologies only 26.4% of the small scale farmers who responded agreed to have accessed extension services before.

Table 4.16 Extension officers and research scientists' the rating of the level of access to extension services by farmers

Rating of the level of access to extension services	Frequency	Percentage
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Very high	0	0
High	0	0
Low	4	76
Very Low	14	14
Total	18	100.0

Table 4.16 represents the extension officers and research scientists rating on the level of access to extension service by small scale farmers. The result shows that 76% of them rated access to extension services was very low while 24% rated access to extension services by small scale famers as low.

Table 4.17 Small scale farmers’ responses on access to extension services by Average monthly income

Average monthly income (Ksh)	Frequency	Percentage	Total
Less than 3,000	0	0	10
3001 to 5000	2	2	9
5001 to 10,000	0	0	21
10,001 to 15,000	7	6	30
15,0001 to 20,000	7	6	26
Above 20,000	13	12	15
Missing	81	74	
Total	110	100	110

Table 4.17 represents the small scale farmers who agreed to access extension service by their average monthly income. Most small scale farmers who have accessed extension services at 12% have higher income levels above Ksh.20,001, higher income levels allows the farmers to be able to meet all the operating expenses required to be able to travel and access extension services which are mostly farmer- demand driven as the study found out

Table 4.18 Frequency of access to extension services on modern agricultural technologies

Frequency of access to extension services	Frequency	Percentage
Rarely	16	14.5
Once a month	10	9.0
Once a year	1	1.0
Frequently	3	3.0
Missing	80	72.5
Total	110	100.0

Table 4.18 represents the small scale farmers’ responses on the frequency of access to extension services the results indicates that most small scale farmers who responded to this question said that they are rarely visited by extension officers for training on modern agricultural technologies.

4.5.2 Frequency of provision of extension services

Data collected on the frequency of provision of extension services by the extension officers to farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers. The results obtained are tabulate in Table. 4.19.

Table 4.19 Frequency of provision of extension services on modern agricultural technologies by the extension officers

Frequency of extension Services provision	Frequency	Percentage
Rarely	5	28
Once a month	1	5
Once a year	0	0
Frequently	0	0
On demand basis	12	67
Total	18	100.0

The results obtained shows that 67% of the extension officers who responded agreed to provide extension services mostly on a demand basis when requested to do so by either the farmers or their bosses. Other responses obtained showed that the extension officers offer extension services either rarely at 28% or once a month at 5%. This concurs with Wambugu (2001) findings where he noted that very few farmers were in constant contact with government extension services on a more regular basis. Frequent availability of extension services has the potential to influence the rate of adoption of new technologies in any farming enterprise. The delivery of extension services on modern agricultural technologies can only be effective if there is constant and more regular contact between the extension providers and the farmers to facilitate the learning process.

4.5.3 Extension training methods and techniques used to train the farmers

Data collected on the extension methods and techniques used to train the small scale farmers by extension officers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers. The results obtained are tabulate in Table 4.20.

Table 4.20 Extension training methods and techniques

Training methods and techniques	Frequency	Percentage
Farmers' training and visits	24	22
Field schools and training centers	2	1.5
ICT and internet delivery	1	0.5
Demonstration fields	12	11
Others	1	0.5
Missing	70	64.5
Total	110	100.0

A majority of the small scale farmers at 60% mentioned farmers training and visits as the common method used to train small scale farmers by extension agents. Set-up demonstration fields were the second most popular training method mentioned by 30% of the respondents. Established field schools and training centers ICT and internet delivery were the other mentioned training methods at 5% and 2.5% in that order. The extension officers were also asked to respond by stating the methods and techniques they mostly use to train the small scale farmers all those who respondents said they use training and visits technique the other techniques mentioned include group training and demonstration field set-ups. The findings were in agreement with other studies which have shown that T&V training method has been mostly used to train the farmers because the model provides farmers with the opportunity to learn by doing the activities they are being trained on practically by the extension agents (Krishna et al, 2012).

4.5.3 Challenges contributing to the low access and provision of extension services

Data collected on the challenges hindering the access and provision of extension services to farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers. The results obtained are given in Table 4.21.

Table 4.21 Challenges hindering the access to extension services on modern agricultural technologies

Small scale farmers' reasons for low access to Extension services	Frequency	Percentage
Lack of information about extension services	21	19
Extension offices are located far off	53	49
Low financial resources	9	8
I farm in remote un accessible region	4	3
Very few extension officers are available	14	13
Missing	9	8
Total	110	100

More than half of the respondents at 52% mentioned extension offices being located very far as the main reason for low access to extension services for instance, 74% of the respondents said the extension offices where the extension officers are based are located over 11km away from their farms where they practice their farming activities therefore it's not easy for them to access the services being offered on a regular basis.

Other responses obtained from the interviewed small scale farmers showed that 5% of the respondents said they lack interest in attending extension training meetings while 9% of the responds mentioned in-frequent visits as their reason for low access of extension services provided while 7% % of the responses obtained showed that the extension officers visits their homes while they are either busy at work or doing business and that the extension officers never visit them again. Extension providers disseminate extension

information to farmers and help them keep abreast with current modern agricultural technology. Inadequate contact between the farmers and extension providers means latest technologies coming out of agricultural research activities will not be effectively disseminated to the end users to help them improve on the up-take of modern agricultural technologies.

The extension officers and research scientist interviewed were also asked to give the possible challenges for the low provision of extension services to farmers 39% of the responses mentioned low government support as the main reason 38% of the responses very few extension officers as the other challenge while 28% of the responses agreed with the observation that low provision of extension services is because of lack of reliable means of transport for the extension officers. The extension officers interviewed were also asked to give the longest distance they cover in order to provide extension services the result obtained shows that 100% of the extension officers cover a distance of more than 6kilometers in order to provide extension services to small scale farmers.

The study found out very low contact between the farmers and extension officers on modern agricultural technologies Wambugu (2001) also found out that only 32% of farmers were in contact with government extension services because of; budgetary limitations and inadequate allocated resources also weak research-extension linkages, unavailability of mobility and lack of training opportunities for updating extension personnel knowledge have also been identified as possible reasons. Mohammad (2012) also observed that poor extension services provision led to the low adoption of improved technology and lack of communication between the rural people and extension agents and shortage of extension agents was one reasons for low adoption of new agricultural technology.

The study established a low level of contact between the extension officers and the small scale farmers within the sub-county contrary to Ogola et al (2010) findings where he observed that high personal contact between farmers and extension officers in the rural context was a more important method of reaching farmers than any other means of communication. Thika East sub-county's rural area is not well served by well-maintained road network and transport is a big problem for the extension officers. This implies that

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

To solve this problem, as the study found out that the government through the National and county agricultural sectors the extension policies enacted should embrace and allow for more involvement of all other stakeholders in offering extension services to the farmers. Increase the budgetary allocation to extension services provision, employ more extension officers and provide all the extension officers with reliable means of transport because most extension officers said they lack reliable means of transport. Further, the quality of extension services offered by the technical extension staff should be regularly improved by regular capacity building sessions organized through workshops or seminar trainings, in-service training and government to government inter-exchange programs with other technical foreign missions can also be initiated foreign- foreign to provide for benchmarking opportunities and more learning for the current extension officers (Umeghalu et al, 2012). These will enable the extension workers to be abreast with emerging technological developments, identify field problems and provide alternative solution to farmers (Umeghalu et al, 2012). Also to promote effectiveness in motivating the farmers to adopt new agricultural technologies improved effective extension methods should be used to train the farmers and this can be ensured through regular staff-training regularly providing them with all the required facilities, reorganization of extension programs and involving local leaders as an agent for dissemination of information (Mohammad, 2011).

4.6 Influence of modern agricultural technologies' information on the adoption of modern agricultural technologies

Data collected on the access to modern agricultural technologies' information was analyzed to establish to what extent it influences the adoption of modern agricultural technologies by small scale farmers.

4.6.1 Access to modern agricultural technologies' information by small farmers

Data collected on the access to modern agricultural technologies' information by small scale farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers. The results obtained are tabulated in Table 4.22.

Table 4. 22 Access to modern agricultural technologies' information

Response	Frequency	Percentage
Yes	99	90
No	11	10
Total	110	100

A majority of the small scale farmers who responded at 90% agreed to access information on modern agricultural technologies through the available sources and communication channels. Implying that most small scale farmer's access information on modern agricultural technologies thus access to information on the existing agricultural technologies does not hinder the adoption of modern agricultural technologies by the small scale farmers in the area of study. The extension officers and KARI Thika research scientists who responded were also asked in their opinion if they thought small scale farmers' access information on modern agricultural technologies 100% of the

respondents agreed that the small scale access information on modern agricultural technologies.

4.6.2 Information sources and communication channels through which the farmers access information on modern agricultural technologies

Data collected on the information sources and communication channels used to access and convey information was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers.

Table4.23 Responses on information sources and communication channels

Information sources	Frequency	Percentage
Newspapers	15	6.1
Internet	17	7.0
Television	57	23.3
Radio	63	25.8
Extension officers	21	8.6
Other farmers/ social networks	57	23.4
My work place	12	5.0
Others	2	1.0
Total	244	100.0

Table 4.23 represents the small scale farmer’s responses on the modern agricultural technologies’ information sources and communication channels they use to access information on modern agricultural technologies a total of 244 responses were obtained from 110 respondents. Most small farmers mentioned Radio as their main source of information and communication channel they use to access information on modern agricultural technologies this is because with the advent of information communication technology digital Radio broadcasting is possible even in the local language making it

more accessible to farmers even to those with low education levels. Other communication channels and information sources for instance newspapers and the internet as the study found out are not commonly used by most rural small scale farmers but only to the well-off rich and highly educated farmers only 6.1% of the respondents said they have accessed information through newspapers while 7% access information through the internet. Since, the study was conducted in a rural village setting where most community members always learn from what their neighbors are practicing 23.4% of the respondents mentioned social networks as their source of information. Some of the respondents are workers at the neighboring plantation farms where most sophisticated modern agricultural technologies are extensively practiced, the reason why 5% of the respondents agreed to have learnt about the new technologies they practice on their farms from their work places. The other sources mentioned that represents 1% of the respondents include books, other literature materials and agro-chemical selling stores where the farmers purchase inputs from.

KARI Thika research scientist and the extension officers who were interviewed were also asked to give the source of information and communication channel in their opinion through which small scale farmers accessed information on modern agricultural technologies majority of the responses mentioned electronic media at 34% other responses obtained include extension officers at 22.6%, other farmers at 28.4% , farmers field days at 3% , individual farmers visits to research centers, agricultural shows, on farm research, other traders, agricultural books and print media all other 2%.

Table 4.24 Information sources and communication channels accessed by highest education levels

Education Level	Mass Media		Extension Officers		Other Farmers		ICT Tools	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
N. A. S	5	5	0	0	10	9		
Primary	16	15	0	0	27	25		
Secondary	41	37	5	5	17	15		
University	11	10	16	15	3	3	15	14

Missing	37	33	89	80	53	48	93	85
Total	110	100	110	100	110	100.0	110	100

Table 4.24 gives the information sources and communication channels accessed by farmers by their highest education levels. Mass media through; Radios and Television are more common information sources and communication channels among all small scale farmers who responded but it's more popular among farmers with low education levels, other farmers through social networks are also common information sources among small scale farmers with secondary school education level and below. Extension officers are only used as an information source by small scale farmers with secondary school and university or college education levels at 24% and 76% in that order. ICT and other modern information sources are more popular among respondents with college and university education levels at 88.2%, small scale farmers with low education levels don't use modern ICT tools as their sources of information. Access to information is critical for the farmers to adopt any modern agricultural technology available, access to information makes farmers more knowledgeable about the existing technologies, and accessed information will assist farmers in the decision making process either to adopt or not adopt the available technologies (Tobon, 2011). The results obtained from both respondents showed that most small scale farmers access information on modern agricultural technologies but a more targeted approach should be used during the dissemination of agricultural information to ensure that information reaches as many farmers as possible taking into account the many sources available that the farmers can use to obtain information about new technologies being disseminated. The results obtained are concurrent to those obtained in a study conducted in Imo state Nigeria among small scale farmers where it was found out that farmer's access information through many available sources. The study found out that highly educated farmers access information through many sources the findings were in agreement with what Torbon (2011) found out in his study that the rich and more educated farmers tend to have greater accessibility to diverse information sources compared to poor smallholder subsistence farmers who only depend on fewer information sources. As the study found out highly educated farmers mostly use

modern ICT information sources and extension officers as their information sources because they are more knowledgeable unlike the farmers with low levels of education.

4.7 Influence of Agricultural research activities on the adoption of modern agricultural technologies

Data collected on access to agricultural research activities by small scale farmers was analyzed to establish to what extent it influences the adoption of modern agricultural technologies by small scale farmers.

4.7.1 Access to agricultural research centers, their research activities and products

Data collected on the access to agricultural research activities by small scale farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers.

Table 4.25 Access to Agricultural research centers, their research activities and products by small scale farmers

Response	Frequency	Percentage
Yes	20	18.2
No	90	81.8
Total	110	100.0

Table 4.25 represents the small scale farmers' responses on access to agricultural research activities provided by the formal agricultural research centers. A huge number of the small scale farmers who responded disagreed that they have never accessed agricultural research products and activities from the available agricultural research

centers, only 18.2% them agreed to have accessed research products from major agricultural research centers.

Table 4.26 Extension officers and Research scientists’ responses on the access to agricultural research centers, their research activities and products by farmers

Response	Frequency	Percentage
Yes	14	78
No	4	22
Total	18	100.0

Table 4.26 represents the extension officers and research scientists’ responses on access to agricultural research centers and the activities provided by the research centers.78% of the respondents agreed that small scale farmers access the agricultural research centers and their products while 22% of them disagreed.

Table 4.27 Ratings of the levels of access to the agricultural research centers, their research activities and products.

Rating of the level of access to research centers and their products	Frequency	Percentage
Very high	0	0
High	0	0
Low	8	44
Very Low	10	66
Total	18	100.0

Table 4.27 represents the extension officers and research scientists’ responses on ratings of the levels of access to agricultural research centers- KARI Thika or another agricultural research center and the research activities and products they offer by small scale farmers. The results obtained shows that 78% of the respondents rated the access to agricultural research centers their research products to be very low while 22% of the

respondents rated the access to agricultural research centers and their products be to low. The findings concur with what Umeghalu (2012) who noted that research products from agricultural research center exist but they are not readily available to the small scale farmers

Some of those small scale farmers who agreed to have accessed some agricultural research products and activities were further asked to give the agricultural research centers from where they have accessed the products 5 % of the small scale farmers mentioned KARI Thika and other University agricultural research centers, 7% said they have accessed them from other private agricultural research companies while 3% mentioned Kenya seed company.

Further 8% of the small scale farmers responded and agreed to have accessed some agricultural research products but not from the formal research centers they mentioned roadside seedling sellers and unregistered seed stores as the sources of the agricultural technologies they have adopted. The main reasons given for adopting sub- standard technology products from the un-registered centers over recognized formal research companies and centers being that they are readily accessible and they sell their products at cheaper prices unlike the formal research centers which are not readily accessible to small scale farmers and their products are sold at high unaffordable prices. This has greatly affected the access to quality technology products being disseminated by the formal research centers and thus their adoption by the small scale farmers.

Table 4 .28 Access to agricultural research centers, their research activities and products by small scale farmers’ average monthly income

Monthly income (Ksh)	Frequency	Percentage	Total
Less than 3,000	0	0	10
3001 to 5000	0	0	9
5001 to 10,000	0	0	21
10,001 to 15,000	1	1	30
15,0001 to 20,000	6	5	26

Above 20,000	13	12	15
Missing	90	82	
Total	110	100	110

Table 4.28 represents those small scale farmers who agreed to have accessed some agricultural research products from formal research centers by their monthly income. Most small scale farmers at 17% who have accessed some modern agricultural technologies and products from agricultural research centers earn an average monthly income more than Ksh.20, 001 this is because with higher income levels the farmers can be able to afford the initial start-up and adoption cost of the technology and also access to all the other complementary requirements and inputs required during the technology adoption process.

4.7.2 Examples of agricultural research products, activities and technologies that have been accessed by farmers

Data collected on the examples of agricultural research products, activities and technologies that have been accessed by small scale farmers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers. The results are tabulated in Table 4.29.

Table 4.29 Agricultural research activities and products accessed by farmers

Agricultural research products accessed	Frequency	Percentage
Tissue culture bananas	5	5
Hybrid seeds	20	18
Drip irrigation	4	3
Greenhouse farming	4	3
Grafted fruit seedlings	15	14
A.I	3	3
Others	5	5

Missing	54	49
Total	110	100

Hybrid seeds were the most mentioned research product to be accessed by most farmers at 37% other products which were mentioned include; Grafted seedlings at 27%, Tissue culture bananas and other research products at 8%, Drip irrigation and Greenhouse farming at 7% and Artificial insemination at 6%. The Research scientists from KARI Thika and extension officers within the sub-county who were interviewed were also asked to give the agricultural research technologies and products which have been accessed by small scale farmers 30 responses were obtained, hybrid seeds at 30%, grafted seedlings at 23.3%, Tissue culture bananas at 16.7%, Post-harvest technologies at 10%, greenhouse farming and A.I at 6.7%, Drip irrigation and Mushroom production technologies at 3.3%. The results obtained on the access to AI technology were consistent with what Kinyanjui (2012) who found out in a study undertaken within Kakuzi division in Muranga County that very few livestock farmers have accessed and practiced the AI technology in their livestock rearing activities.

4.7.3 Challenges limiting the access to agricultural research centers, their agricultural research activities and products

Data collected on the challenges hindering the access to agricultural research activities and products by small scale farmers from the formal research centers was analyzed to determine its influence on the adoption of modern agricultural technologies by small scale farmers. The results obtained are given in Table 4.30.

Table 4 .30 Challenges limiting access to agricultural research centers, their research activities and products

Challenges for the low access of agricultural Research products	Frequency	Percentage
Research centers are located far	36	33
Low financial resources	30	28.7

Inadequate information about research centers	44	38.3
Total	110	100

In the results 110 responses were obtained, 38.3% of the responses mentioned inadequate access to information about the agricultural research activities as the main reason for low access to agricultural research activities, 33% of the responses mentioned the research centers are located very far while 28.7% of the responses given mentioned low financial resources available to farmers as the reason for the low access.

KARI Thika research scientists and the extension officers within the sub-county who were interviewed were also asked to give the reasons in their opinion which thought hinder the access to agricultural research centers and their products from the agricultural research centers in total 34 responses were obtained from the 18 respondents 38% of the responses mentioned inadequate access to information as the main reason, 34% of the responses gave inadequate access to financial resources by farmers, 12% of the responses said KARI Thika is located far away from the small farmers while, 3% mentioned low government support as the last reason. Further KARI Thika research scientist who responded were asked to give the longest distance covered by farmers to access agricultural research services from KARI Thika 100% of the responded agreed that farmers farming at farthest points must cover distances over 10 Kilometers for them to access agricultural research services from KARI Thika.

The findings proofed that for a small scale farmer to access hybrid poultry disseminated from Kenchic a hybrid poultry breeding company operating within the sub-county a farmer must be able to deposit a minimal capital requirement of Kenya shillings one million further it was discovered that for a farmer to be able to obtain a complete modern greenhouse structure from Amiran Kenya Limited he must be able to raise minimum initial capital of Ksh.300, 000 (Mwangi, 2013). Most scale farmers can't afford the high initial start-up capital requirements required by most companies developing agricultural technologies because through the study it was found out that 86% of the small scale farmers who responded earn an average monthly income of less than Ksh20, 000. This concurs with Umeghalu (2012) who noted that most small scale farmers are unable to

access agricultural technologies because of the high initial capital requirements required by the agricultural research companies disseminating them. Further Small scale farmers, research scientist and extension officers all agreed to the fact that low access to agricultural research activities can also be attributed to inadequate access to information about the research centers, their activities and products, this can be explained by the observations made by the respondents who noted that most research centers are located far away from the small scale farmers' farming points, 100% of the KARI research scientists interviewed agreed to the fact that KARI Thika is located over 10 kilometers away from most small scale farmers' farming points, the center is thus un-accessible to most small scale farmers therefore, obtaining information from them becomes difficult.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter contains the summary of findings under all the variables of study; resources, extension services, modern agricultural technologies' information and agricultural research activities. The section also contains conclusions drawn from the findings and the recommendations derived from the results.

5.2 Summary of Findings

This section gives a summary of findings of the study.

5.2.1 Demographic information of the small scale farmers

The study found out that a majority of the small scale farmers who responded were female. The study also revealed that most of the small scale farmers are aged between the ages of 40-60 years with minimal youth participation and involvement in the agricultural activities. There is also limited participation of those aged above 60 years in any agricultural activities and thus the adoption of modern agricultural technologies. The study also found out that majority of the farmers have only attained secondary school education and below some have never attended school only 13% of the respondents have attained college and university education. The study also found out that most small scale farmers are low income earners with 86% of the respondents earning a monthly average income of less than Ksh.20, 000.

5.2.2 Influence of Resource factors on the adoption of modern agricultural technologies

It was evident from the study that most small scale farmers have very low access to credit and loan facilities from banks and other financial institutions operating within the sub-county only 9% of the responding small scale farmers agreed to have accessed credit facilities for their agricultural activities and thus adoption of modern agricultural technologies. KARI Thika research scientist and the extension officers operating within the sub-county who responded 71.1% of them rated access to credit and loan facilities by small scale farmers as very low. The reasons given by the two categories of respondents for the low access to credit facilities include; lack of information on the credit facilities available to farmers, lack of collateral, inadequate and poor banking services in the sub-county, high interest rates was also another mentioned reason. The study found out that most small scale farmers at 94% operate on agricultural land less than 5 acres only 6% of the respondents practice farming activities on agricultural land more than 5 acres.

The study found out that the critical inputs like water, modern equipments and machinery needed for the adoption of modern agricultural technologies by small scale farmers are rarely accessed by the farmers and mostly those who access them get them by buying, borrowing from neighbors and hiring them, only 11 % of the respondents said they access

inputs, low access to inputs, equipments and machinery by farmers has negatively affected the adoption of modern agricultural technologies. The study found out that the establishment of government or community input stores, subsidizing of input prices by the government and construction of water dams at the village levels can help alleviate the problem of scarcity of essential inputs required for the adoption of modern agricultural technologies. There was a positive correlation coefficient of 0.6 between the levels of monthly income of farmers and access to agricultural inputs required for agricultural activities those farmers with high levels of income easily access the inputs required for the adoption of modern agricultural technologies.

5.2.3 Influence of Extension services on the adoption of modern agricultural technologies

The study established low access to extension services by small scale farmers 73.6% of the respondents said they have never accessed extension services on modern agricultural technologies because they live further away from the extension offices where the extension agents and officers are based because the further the small scale farmers live away from the extension offices the lower the tendency to visit the offices for advice for instance 52% of the respondents said they have never accessed extension services because the extension officers are located very far away. The other reasons given by farmers for low access to extension services include; lack of information about the existence of extension services at 21%, very few extension officers at 14% low financial resources at 9% in-frequent visits by extension officers at 9% and lack of interest by farmers to be trained at 5%. The extension providers also agreed that they rarely visit the small scale farmers on their farms to provide extension services because of; low government support to extension services by the respective government agencies, very few extension officers covering bigger and wider spread areas and lack of reliable means of transport for the extension officers to make frequent visits to all farmers.

5.2.4 Influence of modern agricultural technologies' information on the adoption modern agricultural technologies

The study found out that 90% of the responding small scale farmers agreed to access information on modern agricultural technologies only 10% of the small scale farmers who responded said they have never accessed information on modern agricultural technologies. All the extension officers and research scientists who responded also agreed to the fact that most farmers access information on modern agricultural technologies. All the three categories of respondents agreed that the most common information source to small scale farmers is electronic mass media through Radios and Television other sources also mentioned include; community social networks, extension officers, print media through newspapers, internet, work place, books and other literature materials. The study found that the education levels of respondents influence which type of information sources the farmers which use to access information on modern agricultural technologies. Farmers with higher educational levels tend to have diverse information sources to access information on modern agricultural systems unlike farmers with low education levels who only depend on a few information sources. Farmers with low education levels tend to only mass media sources; Radio and Television while modern ICT tools and extension officers are mostly used by college and university graduate farmers as their sources of information.

5.2.5 Influence of agricultural research activities on the adoption of modern agricultural technologies

The study discovered that few farmers at 18.2% have accessed agricultural research activities, products and technologies disseminated from the formal registered agricultural research institutions and centers within the sub-county and country at large The extension officers and research scientist who responded 78% of them agreed to the fact that access to agricultural research products by small scale farmers is very low while 22% of them said access to agricultural research products by small scale farmers is low. KARI Thika is the major agricultural research center in the region from where most small scale farmers

should be able to access the modern agricultural technologies being developed and released to farmers but only 5% of the respondents said they have obtained modern technologies from the center. The small scale farmers mentioned lack of adequate financial capital, inadequate access to information about the research centers and the centers being located very far as the main reasons for not accessing modern agricultural technologies from the research centers developing and disseminating the research products. The research scientists who responded agreed that KARI Thika is located over 10km from the most distant small scale farmers its therefore far and not easily accessible to most small scale farmers the observation concurs with 33% of the small scale farmers responses who said that most agricultural research centers are located very far away from their farming points where they practice agricultural activities as the reason for low access to agricultural research products.

5.4 Conclusions of the study

Based on the results of the study the following conclusions were drawn based on the objectives of the study in relation to adoption of modern agricultural technologies by small scale farmers;

It was very evident from all the three categories of respondents that the small scale farmers have limited access to resources required for agricultural production for instance land, agricultural inputs, water, modern equipments and machineries and financial resources low access to resources required for agricultural production has thus negatively influenced the adoption of modern technologies. It's thus imperative that the Kenyan government should subsidized inputs for the farmers as well as establish community input stores which will make the inputs more easily accessible and available to the small scale farmers for the adoption of modern agricultural technologies. Modern agricultural equipment and machinery hire services should be established the County governments to the enable small farmers have access the modern equipments and machineries easily and at a low cost.

The provision and delivery of extension services to small scale farmers can only be effective if there is constant contact between the extension providers and the small scale

farmers being served, the study discovered a low contact between the farmers and extension officers the farmers thus have a low access of extension services the implication of the low access to extension services being inadequate transfer of knowledge between the extension officers and farmers thus influencing the adoption of modern agricultural technologies negatively. The study also found out that most farmers have low levels of education it can therefore be concluded that most farmers with low education levels are not able to access extension services information provided through other communication channels like the internet which requires higher education levels.

The study found out from all the three categories of respondents that most small scale farmers' access information on modern agricultural technologies for instance 90% of the small scale farmers accepted to access information on modern agricultural technologies through electronic mass and print media, extension officers, other farmers by social networks and modern ICT communication tools thus it can be concluded that access to information does not influence adoption of modern agricultural technologies within the sub-county in a negative way. Further, it was evident from the study that most small scale farmers have low education levels this has limited the diverse means they can use to access information on modern agricultural technologies since small scale farmers with low education levels access information from few information sources.

The study found that small scale farmers have low access to agricultural research activities, products and technologies being disseminated from most agricultural research centers within the sub-country and country at large, as the study found out low access to agricultural research activities by farmers can be attributed to limited access to financial resources by farmers because most farmers are low income earners, low access to information about the research centers and their activities because most agricultural research centers are located far away from the farmers' farming points. It can thus be concluded that low access to agricultural research products by small scale farmers has negatively influenced on the adoption of modern agricultural technologies by farmers.

5.5 Recommendations of the research study

This research study recommends that:

1. Due to low levels of education characterizing the small scale farmers, adult education should be integrated with trainings on modern agricultural technologies.
2. The government should employ more extension staff and deploy them to more decentralized levels at locations and villages levels so that contact between the farmers and the extension officers is improved. Training of community extension persons who can assist the extension officers in disseminating extension information should be embraced.
3. The government should enhance budgetary allocation to extension services
4. The government should subsidize the prices of inputs, equipments and machinery required for the adoption of modern agricultural technologies by small scale farmers and make them more affordable to the farmers with low income levels.
5. More trainings and capacity building of the small scale farmers should be initiated on all the available modern agricultural technologies this will increase the levels of awareness of the existing modern agricultural technologies.
6. Credit advancing institutions should be more flexible in extending loans to the small scale farmers with no collateral and at low interest rates. This will assist the small scale farmers; youth and women who have no security or collateral to access loans.
7. The major financial institutions operating in the region should open more branches into the rural areas so as to be more accessible to the small scale farmers, more trainings and educating forums should also be initiated to educate farmers more on the credit facilities available.
8. Proper legal framework should also be put in place to formalize other informal ways of lending which are already being used to those small scale farmers with who lack any formal monthly incomes for instance table banking and 'shylock lending'.
9. The government should facilitate the lowering of interest rates charged on loan facilities granted to small scale farmers so as to make it easier for them to access credit from the major lending financial institutions.
10. Agricultural loan schemes and modern equipments financing should be initiated by the National and county governments at low interest rates to facilitate the small

scale farmers' access finance for the purchase of inputs, modern agricultural machines and equipments.

11. Through the Ministry of lands and other relevant government institutions the government should quicken the process of issuing title deeds to those small scale farmers who own land but lack proper titles for their pieces of land, the titles will enable them access credit facilities from financial institutions by using them as collaterals.
12. Due to the low levels of farmers' income as the study found out its recommended that the farmers should pool resources together and purchase the modern equipments and machinery in groups this will enable them to adopt the modern agricultural technologies which as individual farmers it may not be easy for them to adopt.
13. The government through its agricultural research centers should facilitate the decentralization of research activities into the rural areas in Kenya to make them more accessible to the rural farmers for instance KARI Thika the main agricultural center in the region should establish sub-centers within the sub-county to make the services they offer more accessible to most small scale farmers.

1.5 Suggestions for future research

Further research is recommended on the following areas;

1. Factors influencing the use of ICT in delivery of extension services to small scale farmers.
2. Factors contributing to the poor delivery of extension services to small scale farmers.
3. Factors affecting the dissemination rates of modern agricultural scientific research innovations from agricultural research centers

REFERENCES

- Abdullah, A., Gillani, W. A., Naveed, S., Amanullah, K., & Kashif, H. (2005). *Computerized farm guide: Using ICT for better dissemination of agriculture extension information*. Center for Agro-Informatics Res. National Univ.of Computer & Emerging Sci. Islamabad, Pakistan

- Ahuya, C.O. & Okeyo, A.M. (n.d). *Productivity of cross-bred goats under smallholder production systems in the Eastern highlands of Kenya*, FARM-AFRICA, Nairobi, Kenya. Retrieved from: <http://www.farmafrica.org.uk>
- Anderson, J. R., Feder, G. & Ganguly, S. (2006). ‘The Rise and fall of Training and Visit Extension: An Asian Mini-drama with and African Epilogue’, *World Bank Policy Research Working Paper 3928*, World Bank, Washington D.C, from <http://ideas.repec.org/p/wbk/wbrwps/3928.html>
- Ayesha, K. & Muhammad, A. (2012). Farmers’ perception of extension methods used by extension personnel for dissemination of new agricultural technologies in Khyber Pakhtunkhwa: Pakistan *Sarhad J. Agric.* Vol.28, No.3.
- Batz, F. J. Peters, K. J. & Janssen, W. (1999). The influence of technology characteristics on the rate and speed of adoption, *Agricultural Economics*, 21, 121 -130. Website: [http://dx.doi.org/10.1016/S0169-5150\(99\)00026-2](http://dx.doi.org/10.1016/S0169-5150(99)00026-2)
- Birner, R., Davis, K., Pender, J., Nkonya, E., Anandajayasekeram, P., Ekboir, J., Mbabu, A., Spielman, D., Horna, D., Benin, S. & Cohen, M. (2006). ‘From “Best Practice” to “Best Fit”’: *A Framework for Analyzing Pluralistic Agricultural Advisory Services Worldwide*’, DSGD Discussion Paper No. 37, IFPRI, , Washington D.C. Published version: *Journal of Agricultural Education and Extension* 15 (4), pp. 341-355, December 2009
- Droesch, A. C. (2015). *Technology diffusion, outcome variability, and social learning: Evidence from a field experiment in Kenya*. Job Market Paper.

- Boz I., Akbay, C., & Orhan., E. (2002). The Factors Adoption and Diffusion of Corn Production in Kahramanmaras. Turkey, *the V. Congress of Agricultural Economics* (18-20 September), Erzurum, pp. 440-448.
- David, S. & David, Z. (2000). *The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector*. Handbook of Agricultural Economics
- Dercon, S. & Christiaensen, L. (2011). Consumption risk, technology adoption and poverty traps: evidence from Ethiopia. *Journal of Development Economics*, 96(2):159-173.
- Ehler, L.E. & Bottrell, D.G. (2000). *The illusion of integrated pest management. Issues in science and technology*. Bell and Howell Information and Learning Company, pp61-64
- Eicher, C. K. (2001). *Africa's un-finished business: Building sustainable agricultural research systems*. Staff paper 20001-10. Dept. of Agric. Econ. Michigan State Univ. East Lansing, Michigan.
- El-Osta, H. S. & Morehart, M. J. (2002). Technology Adoption and Its Impact on Production Performance of Dairy Operations, *Review of Agricultural Economics*, 22, 2, 477-498, website: <http://dx.doi.org/10.1111/1058-7195.00034>
- Fan, S. & Rao, N. (2003). *Public Spending in Developing Countries: Trends, Determination, and Impact*, EPTD Discussion Paper, No. 99, IFPRI, Washington D.C, Website: <http://ideas.repec.org/p/fpr/eptddp/99.html>
- Farooq, A. & Ishaq, M. (2005). Devolving the farm extension system. P: III. *Economics & Business Rev.* Daily Dawn, Karachi. Monday, 2005

- FAO. (2014). *Statement at the Ministerial Conference of the WTO - Circulated by H.E. Mr. Hartwig de Haen, Assistant Director-General, Fifth Session, Cancun, 10-14 September, Doc No: WT/MIN (03)/ST/61*
- Feder, G., Murgai, R. & Quizon, J. B. (2004), 'The Acquisition and Diffusion of Knowledge: The Case of Pest Management Training in Farmer Field Schools, Indonesia', *Journal of Agricultural Economics* 55 (2), pp. 221-243
- Foster, A. & Rosenzweig, M. (1995). Learning by Doing and Learning from Others: Human Capital and Farm household Change in Agriculture. *Journal of Political Economy* 103(6):1176-1209
- Gabre, M. E.Z. & Haggblade, S. (2001). Success in African agriculture: *Results of an expert survey*. International Food Policy Research Institute, Washington DC.
- Garforth, C., Angell, B., Archer, J. & Green, K. (2003). Fragmentation or creative diversity? Options in the provision of land management advisory services, *Land Use Policy*, 20, 323-333, from, [http://dx.doi.org/10.1016/S0264-8377\(03\)00035-8](http://dx.doi.org/10.1016/S0264-8377(03)00035-8)
- Ingold, T. (2002). *The Perception of the Environment, Essays in livelihood, dwelling and skill*. Publisher Routledge Taylor & Francis Group, London and New York. p. 294-322.
- Kabunga, N.S., Dubois, T., Qaim, M. (2012). Heterogeneous information exposure and technology adoption: The case of tissue culture bananas in Kenya. *Agricultural Economics DOI: 10.1111/j.1574-0862.2012.00597.x*.
- Kabunga, N. S., Dubois, T., Qaim, M. (2012). Yield effects of tissue culture bananas in Kenya: Accounting for selection bias and the role of complementary inputs. *Journal of Agricultural Economics* 63, 444-464.
- Karlan, D. Osei, R. Osei, A, & Udry, C. (2014). Agricultural decisions after relaxing risk and credit constraints. *Quarterly Journal of Economics*.

- Khanal, A. R. & Gillespie, J. M. (2011). Adoption and Profitability of Breeding Technologies on United States Dairy Farms, *Southern Agricultural Economics Association Annual Meeting*, Corpus Christi, TX, February 5-8, 2011
- Kinyanjui. S. W., (2012). *Social-Economic factors influencing sustainability of DairyGoat farming in Kenya. A case of Kakuzi Division in Thika East District*, University of Nairobi, Kenya.
- Kipserem, J., Sulo, T., Chepng'eno, W. and Korir, M. (2011). Analysis of factors affecting dairy goat farming in Keiyo North and Keiyo South Districts of Kenya; *Journal of development and Agriculture Economics* Vol 3 (11) pp. 555-560,12 October, 2011
- Kombo,D. K & Tromp, D., (2013 13th reprint). *Proposal and thesis writings*. Nairobi: Don Bosco Prining press
- Kothari, C. R. (2004). *Research methodology, methods and techniques*, will Eastern limited, New Delhi.
- Krejcie, R.V. & Morgan, D.W. (1970). *Determining sample size for research activities. Educational and psychological measurement*. 30. p. 607-610.
- Krishna, M.S., Burton, E. S., Awadhesh , K. J. & Mohar, S. M. (2012). *Extension Reforms and Innovations in Technology Dissemination-ATMA Model in India*, website; <http://dx.doi.org/10.2139/ssrn.2168642>
- Langat, B. K., Ngéno, V. K., Nyangweso, P. M., Mutwol, M. J., Kipsat, M. J., Gohole, L., & Yaninek. S. (2014). *Drivers of Technology Adoption in a Subsistence Economy: The case of Tissue Culture Bananas in Western Kenya*. Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia.

- Lopokoiyit, M., Onyango, C. & Kibett, J. K. (2013). Extension Management Competency Needs of Agricultural Extension Agents in Kenya. *Mediterranean Journal of Social Sciences*, 4 (6).
- Mamudu, A. Akudugu, E. G. Dadzie, K. S. (2012). Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions. *Journal of Biology, Agriculture and Healthcare* 2, 3, 2012 website; www.iiste.org
- Mapila, M. A. T. J. (2011). Rural livelihoods and agricultural policy changes in Malawi. *Agricultural Innovations for Sustainable Development*. In: Manners, G. & Sweetmore, A., (Editors). Accra-Ghana, CTA and FARA, 3, 190-195.
- Mashall, B. & Miguel, E. (2014). *Innovative Finance for technology adoption in Western Kenya*. Innovation for poverty publication from; www.povertyactionlab.org
- Ministry of Food and Agriculture. (2010). *Agriculture in Ghana: Facts and figures*. Government of Ghana Publications, 1-41.
- Mohammad, J. U. D. (2011). The socio-economic problems of small farmers in adopting new agricultural technology: A case study of three villages in district Mardan. *Sarhad J. Agric.* 27, (2),
- Mugenda, O., & Mugenda, A. (2004). *Research Methods - Quantitative and Qualitative Approaches*. Acts press, Nairobi.
- Mwangi, I. (2013). *Hydroponics Give Kenyan Farmers Fodder For*. Publication in Afk insider, website, <http://afkinsider.com/10663>

Ngari, T.D.O. (2007). *An assessment of gender mainstreaming in food security extension programmes in Central division, Kitui district*. (Unpublished master's Thesis). University of Nairobi.

Njuguna, M., Wambugu, F., Acharya, S., Mackey, M. (2010). *Socio-economic impact of tissue culture banana (Musa Spp.) in Kenya through the whole value chain approach*. In: Dubois T., Hauser, C., Staver, D., Coyne, D. (Eds.), in Proceedings of the International Conference on Banana and Plantain in Africa: Harnessing International Partnerships to Increase Research Impact, 5-9 October, 2008, Mombasa, Kenya. *Acta Horticulturae*, pp. 77–86

Olembe, O.O. (2010). "The Plant Biotechnology Flight: Is Africa on Board?" *African Journal of Biotechnology*, 9, pp. 4300-4308

Ogada, J. M., Germano, M., & Muchai, D. (2014). Farm technology adoption in Kenya: a simultaneous estimation of inorganic fertilizer and improved maize variety adoption decisions. *Agricultural and Food Economics Journal*, 2:12 website; <http://www.agrifoodecon.com/content/2/1/12>

Ogola, T.D.O., Nguyo, W.K. & Kosgey, I.S. (2010). Dairy goat production practices in Kenya: Implications for a breeding programme. Egerton University, Kenya. Website: [http:// www.Irrd.org/Irrd22/1/ogo122016.htm](http://www.Irrd.org/Irrd22/1/ogo122016.htm)

Prokopy, L. S., Floress, K., Klotthor, M. & Baumgart, G. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation*, 63, 5, 300-311, from <http://dx.doi.org/10.2489/jswc.63.5.300>

- Rehman, T., McKemey, K., Yates, C. M., Cooke, R. J., Garforth, C. J., Tranter, R. B., Park, J. R., & Dorward, P. T. (2007). Identifying and understanding factors influencing the uptake of new technologies on dairy farms in SW England using the theory of reasoned action, *Agricultural Systems*, 94, 281-293, from, <http://dx.doi.org/10.1016/j.agsy.2006.09.006>
- Rogers, E. M. (2003). *Diffusion of Innovations*. 5th ed. New York: The Free Press.
- Singh, K. M., Singh, R. K. P., Abhay, K. & Anjani, K. (2014). *Adoption of Modern Agricultural Technologies: A Micro Analysis at Farm Level in Bihar*, MPRA Paper No. 58914, website; <http://mpra.ub.uni-muenchen.de/58914/>
- Solomon, A., Bekele, S., Leslie, L & Franklin, S. (2012). Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia, *Food Policy Journal* 37 (3) 283–295
- Sunding, D. & Zilberman, D. (2001). *The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector*. Gardner, B. & Rausser, G. Handbook of Agricultural Economics, Vol.1, Elsevier Science B.V.
- Toborn, J. (2011). *Adoption of agricultural innovations, converging narratives, and the role of Swedish agricultural research for development*. Discussion, paper version 2011-01-28
- Truong, T. N. C. & Ryuichi, Y. (2002). Factors affecting farmers' adoption of technologies in farming system: A case study in OMon district, Can Tho province, Mekong Delta. *Omonrice* 10: 94-100.
- Turkylmaz, M. K., Bardakçioğlu, H.E. & Nazlıgül, A. (2003). The Socio-Economic Factors Effective for the Adoption of Innovations at the Dairy Farms at the Province Of Aydın. *Turk. J. Vet. Anim. Sci.*, 27(6):1269-1275.
- United Nations, Food and Agriculture Organization. (1997). *The State of Food and Agriculture*. Rome.

Umeghalu, I. C .E., Okonkwo, J. C. & Nwuba, E .I .U. (2012). Modern technologies and Nigerian's small scale farmers: constraints and prospects of its adoption. *Scientific Journal of Agricultural* 1(4) 68-73 .

Van den Berg, H. & Jiggins, J. (2007). 'Investing in Farmers – The Impacts of Farmer Field Schools in Relation to Integrated Pest Management', *World Development* 35 (4), pp. 663-686.

Vishwanath, R. (2003). Artificial insemination: the state of the art. *Theriogenology*, 59, 571-584, website: [http://dx.doi.org/10.1016/S0093-691X\(02\)01241-4](http://dx.doi.org/10.1016/S0093-691X(02)01241-4)

Wanyama, J. M., Obare, A.G., Owuor, G., Wasilwa, L.(2013). Factors Influencing Adoption of Tissue Culture Bananas in Western Kenya. *A Research Paper presented at an International workshop for 4th conference of AAAE in Tunisia.*

William, C. M. (2010). Modern Agriculture and Its benefits-Trends, Implications and Outlook. *Global Harvest Initiative Publication No; 3-16-10.*

World Bank. (2014). *World Bank Data*. Website; <http://data.worldbank.org/>.

World Bank. (2007). *Beating the Odds: Sustaining Inclusion in a Growing Economy. A Mozambique Poverty, Gender and Social Analysis..* Report 40048/MZ

World Bank. (2007) *World Development Report 2008: Agriculture for Development*, World Bank, Washington, and D.C. Website: http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf

Appendix 1: Letter of Transmittal of Data Collection Instruments

Robin Nyandika Ngongo,
P.o Box 147,
Thika.

To whom it may concern,

Dear Sir/Madam,

RE: REQUEST FOR ASSISTANCE IN MY ACADEMIC RESEARCH PROJECT

I am a post graduate student at the University of Nairobi pursuing a Masters of Arts Degree in Project Planning and Management. I am currently undertaking my research project on ‘Factors Influencing the Adoption of Modern Agricultural Technologies by small scale farmers: The Case of Thika East Sub-County and KARI-Thika’.

I am pleased to inform you that you have been selected as one of the respondents to participate in the study. I therefore request you to provide accurate data through the questionnaire provided. Please respond to all items. Your identity will be treated with utmost confidence and the data provided will be used only for academic purposes.

Thanks for your assistance and willingness to participate in this research project.

Ithanga () Nanga () Magogoni ()

5. How long have you practised agricultural or farming activities?

Less than 5 years () more than 5 years ()

6. Which agricultural (farming) activities do you practise or have you ever practised on your farm. (Mutiple answers can be given)

Crop farming () Livestock rearing () Mixed farming ()

If crop farming which crops do you grow?

Vegetables () fruits () cash crops () Maize and other cereal crops ()

If Livestock rearing which livestock do you keep?

Hybrid cattle and poutly () traditional cattle and poutly ()

7. What are your source(s) of personal income (tick or underline, multiple answers allowed)

I Lack any formal source of income () Salary ()
Personal saving () Business income ()
Farming income ()

Any other specify.....

What is your monthly average income range in (Ksh) (tick or underline)

Less than 3,000 () 3001 to 5000 () 50001 to 10000 ()

10,001 to 15,000 () 15,001 to 20,000 () Over 20,001 ()

Section B: Resources and adoption of modern Agricultural technologies

8. Have you ever with ease accessed or obtained credit or loan from any financial institution for modern agricultural technology adoption purpose (tick or underline)

Yes () No ()

If No why? Lack of collateral (security) ()

Inadequate information on credit/loan facilities ()

Inadequate banking services ()

Poor banking services ()

Any others. (Specify).....

9. Do you own the land on which you practise the agricultural activities

Yes () No ()

If yes Whats is the size land on which you practice agriculture (tick or underline)

Less than one acres () Between 1 and 2 acres () between 2.1 and 5acres ()
Between 5.1and 8 acres () between 8.1 and 10 acres () More than 10 acres ()

10. Do you easily access all the necessary required agricultural production inputs, modern equipments and machinery required for the adoption of modern agricultural technologies that you ? (tick or underline)

Yes () No ()

Which agricultural production inputs, modern equipments and machinery do you have access to? (Underline or tick)

Water () Seeds () Fertilizer () Pesticides () chick incubator ()

Milking machines () electricity/reliable source of power ()

Others specify.....

If yes how do you access the agricultuaral production inputs required for the adoption of modern agricultural technologies (tick)

Purchase () Governement grants ()

Any other specify.....

If No why: Vendor stocking or selling the inputs are located very far ()

Lack capital or financial resources to buy the inputs ()

High prices of inputs make them unaffordable ()

No governments grants to make them easily available ()

Others specify.....

If no give the possible strategies that will make the inputs readily available to the small scale farmers

Government should subsidize/ reduce the prices of inputs ()

Government should increase the provision of input loans ()

Government should establish input community stores ()

Others.....

Section C: Extension services and Adoption of modern Agricultural Technology

11. Do you access extension services from Thika east sub-county extension officers on modern agricultural technologies and there adoption?

Yes () No ()

If yes in quiz 5 in your own opinion how often do you access the extension services by the extension officers? (Tick one)

Rarely () Once a month () Once a year () Frequently ()

Any other specify.....

If Yes in quiz 5 (Tick or underline, multiple answers allowed) the extension training methods and techniques used by the extension officers in training you on modern agricultural technologies?

Farmers training and visits ()

Farmers field schools and training centers ()

ICT and internet based delivery ()

Demonstration field ()

Any other specify.....

If yes in quiz 5 in your own opinion are the method and techniques used effective in training you on the on the modern agricultural technologies

Yes () No ()

If Yes rate the effectiveness of the extension methods and services (tick only one)

V good () Good () Average () Poor () V poor ()

If V poor or poor give possible reasons why?

Poor training methods techniques used () Language barrier ()

Poor delivery techniques ()

If No in quiz 5 what are the possible reasons why you have never accessed extension services or why you obtain them Rarely? (Tick)

Lack of information about the existance of extension services ()

Extension offices are located very far away ()

The place I do my farming is remote and not easily accessible ()

Very few extension officers available ()
Others.....

12. If no in quiz 5 give the approximate distance between your farm and the extension offices within the sub-county in kilometers

Less than 2 kilometers () Between 2 and 5 kilometers ()
Between 6 and 10 kilometers () More than 10 kilometers ()

Section D: Modern agricultural technologies’ Information and adoption of modern agricultural technology

13. Do you access Information on modern agricultural technologies? (Tick)

Yes () No ()

If yes, (Tick or underline) the main sources of information and communication channels through which you access information on modern agricultural technologies and innovations?

Newspapers () Internet ()
Television () Extension officers ()
Radio () Other farmers/social networks ()

Any other specify.....

14. If yes in quiz 6 are the sources and communication channels you have mentioned above effective in enabling you access information on modern agricultural technologies

Yes () No ()

If yes in question 7. above what sources of information and communication channels that you have mentioned above are the most effective in enabling you access information on modern agricultural technologies.....

If No in Question 7 above give the barriers to effective access of information on modern agricultural technologies.

Language barrier () inaccessible/ poor extension services ()
Unaccessible electronic media ()

Others.....

Sesction E: Agricultural Research ativities and adoption of modern agricultural technologies

15. Have you ever accessed any agricultural research (services) activities or products from the formal agricultural research centers or companies within Thika East sub-county

Yes () No ()

If yes from which formal agricultural research centers or companies

KARI Thika ()

Others.....

If others which are not formal research centers or companies name them.....

If yes which research activities or modern technologies have you ever accessed?

Tissue culture bananas () Post harvest technologies ()

Hybrid seeds () Genetic engineering agricultural products ()

Others.....

If No why or what are the challenges why you have not accessed any agricultural research (services) activities or products?

Agricultural research center are located far and not accessible ()

I dont know of any Agricultural research center in the sub-county ()

I lack financial capital to anable me access the resarch activities offered ()

I lack information about any research activities (services) being offered ()

Any other reason (s).....

Section F: Adoption of modern agricultural technologies

16. Have you adopted any modern agricultural technologies

Yes () No ()

If yes, which modern agricultural technologies have you adopted? (Tick-multiple answers allowed)

Green house and fertigation technologies ()

- Hydroponics technology ()
- Drip irrigation technology ()
- Hybrid seeds ()
- Biotechnology/ Tissue culture (Bananas) ()
- Artificial insemination ()
- Incubator chicken breeding ()

Any other specify.....

If Yes Why did you adopt that or those given technologies?

- Just on trial ()
- Expected high returns/ yields ()
- To reduce the cost farming ()
- To make farming operation more easy ()

Others

If yes what amount of your monthly income do you invest or use for the adoption of modern agricultural technologies you have adopted

- Less than 3,000 () 3001 to 5000 () 50001 to 10000 ()
- 10,001 to 15,000 () 15,001 to 20,000 () Over 20,001 ()

If yes what size of your land is under the adopted new technologies on your farm

- Less than one acres () between 1 and 2 acres () between 2.1 and 5 acres ()
- Between 5.1 and 8 acres () between 8.1 and 10 acres () More than 10 acres ()

If Yes in your own opinion what are the benefits of adopting any modern agricultural technology that you have adopted on your farm? (Tick multiple answers allowed)

- Increased output yields ()
- Reduced cost of agricultural activities ()
- Increased Agricultural income ()

Any other specify

If no in quiz 9 above ,in your own opinion what are the possible reasons or challenges why you have not adopted any modern agricultural technologies?

- Inadequate access of capital / financial resources ()

- Lack of enough land ()
- Inadequate access to inputs required for adoption ()

Appendix 3: Questionnaire for KARI Thika research scientists and Extension officers

This questionnaire is on assessment of the ‘Factors influencing the Adoption of Modern Agricultural Technologies by small scale farmers: The Case of Thika East Sub-County and KARI-Thika’. The exercise is in line with the requirement for the award of the Degree of Masters of Arts in Project Planning and Management of the University of Nairobi. The data collected will be used for the said purpose only. Your identity will be held with strictest confidence.

Below are some questions to assist in establishing the factors influencing the Adoption of Modern Agricultural Technologies by small scale farmers in Thika East Sub-county and KARI Thika. The questionnaire contains 6 sections, kindly respond to all the questions in all sections by ticking or underlining or by explaining your opinion briefly in the space provided.

Section A: Demographic Information of Respondents

1. Indicate your gender Male () Female ()
2. Give your age range in years (tick or underline)
 20-30 () 31-40 () 41-50 () 51-60 () 61 and Above ()
3. Indicate your highest level of educational level training attained
 Not trained () Degree ()
 Certificate () Masters ()
 Diploma () Phd ()
4. How long have you participated in agricultural research activities
 Less than 4 years () Between 5 and 9 years () more than 10 years ()

Section B: Resources and adoption of modern Agricultural technologies

5. Can you rate the level of the small scale farmers monthly income within thika sub-county

Very high () High () low () Very low ()

6. In your opinion, what is the availability of agricultural inputs, equipments and machinery required for the adoption of modern agricultural technologies

Rarely available () Available sometimes () Always available ()

Not available at all ()

If rarely available or not available at all give the possible reasons why

Vendors/stockist selling them are located very far ()

Lack if capital/ financial resources to buy them ()

High cost/ prices ()

Others.....

If the the availability of inputs is rarely available or not available at all give the possible solution on how the availability can be improved

Government should subsidize the prices of inputs ()

Government should increase the provision of input loans ()

Government should establish input community stores ()

Others.....

7. Rate the level of access of credit by the small scale farmers for the adoption of modern agricultural technologies ?

Very high () High () low () Very low ()

If low or very low give the possible reasons why

Lack of collateral (security) ()

Inadequate information on credit/loan facilities ()

Inadequate banking services ()

Poor banking services ()

Any others. (Specify).....

Section C: Extension Services and adoption of modern agricultural technology

8. Rate the level of access of extension services on modern agricultural technologies by small scale farmers

Very high () High () low () very low ()

If low or very low give the possible reasons

Inadequate government funding () Inadequate poor means of transport ()

Very far located farmers () Lack of willingness by farmers to be trained ()

Very few extension officers ()

Any others.....

9. What training method or techniques do you use when offering extension services to small scale farmers

Farmers training and visits ()

Farmers field schools and training centers ()

ICT and internet based delivery ()

Demonstration field ()

Any other specify.....

10. At what frequency do you normally offer extension services to small sale farmers on modern technolog

Rarely () Frequently () Once a month () Once a year ()

Any other specify.....

If Rarely what are the possible reasons/ challeges

Inadequate government funding () Inadequate poor means of transport ()

Very far located farmers () Lack of willingness by farmers to be trained ()

Very few extnsion officers ()

Any other.....

In your opinion what should be done to improve the quality of extension services offered to small scale farmers inorder to promote the adoption and diffusion of modern technologies to small scale farmers

- Lack interest by the small scale farmers ()
- KARI thika is located far way from most small scale farmers ()
- Low government support ()

Others.....

If **yes** which research activites/ services or modern technologies have been mostly accessed by small scale farmers from KARI Thika

- Hybrid seeds ()
- Post harvest handling technologies ()
- Fruits and nuts Grafted seedings ()
- Cut flower planting materials ()

Others.....

14. What is the longest distance that must covered for KARI Thika to provide agricultural research services to small scale farmers located far within Thika east sub-county

- Less than 2 kilometers () Between 2 and 5 kilometers ()
- Between 6 and 10 kilometers () More than 10 kilometers ()

Section F: Adoption of modern agricultural technologies

15. As a KARI research scientist what modern technologies has your center dessiminated and have been adopted by small scale famers inThika East sub-county?

- Post harvest handling technologies ()
- Tissue culture bananas ()
- Hybrid seeds ()

Others.....

16. How can you rate the level of adoption of modern agricultural technologies by small scale farmers in Thika East sub-county

- Very low () Low () High ()

If low or very low give the possible reasons or challenges why?

- Inadequate capital/ low levels of income by farmers ()
- Low government support ()

Inadequate access to agricultural inputs, equipments and machinery ()

Lack of information about modern technologies ()

Appendix 5: Research Authorization Letter



**NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION**

Telephone: +254-20-2213471,
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9th Floor, Utalii House
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P. O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/16/50069/13463**

Date:
4th October, 2016

Robin Nyandika Ngongo
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "*Factors influencing the adoption of modern agricultural technologies by small scale farmers: The case of Thika East Sub-County and Kenya Agricultural Research Institute-Thika, Kenya,*" I am pleased to inform you that you have been authorized to undertake research in **Kiambu County** for the period ending **3rd October, 2017.**

You are advised to report to **the Director, Kenya Agricultural Research Institute, the County Commissioner and the County Director of Education, Kiambu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.


BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The Director
Kenya Agricultural Research Institute.

The County Commissioner
Kiambu County.

The County Director of Education
Kiambu County.

National Commission for Science, Technology And Innovation Is ISO 9001:2008 Certified

Appendix 6 : Research Permit

