FACTORS INFLUENCING THE ADOPTION OF AGRICULTURAL TECHNOLOGY AMONG SMALLHOLDER FARMERS IN KAKAMEGA NORTH SUB-COUNTY, KENYA

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DECLARATION

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

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This research project has been submitted for examination with my approval as the University of Nairobi supervisor.

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LIST OF ABBREVIATIONS AND ACRONYMS

AT	Agricultural Technology
CGIAR	Consultative Group on International Agricultural Research
FAO	Food and Agriculture Organization
IPM	Integrated Pest Management
NC3Rs	National Centre for the Replacement , Refinement and Reduction of Animal in Research
UNDP	United Nations Development Programme
TAT	Traditional Agriculture Technologies

ABSTRACT

The purpose of this study was to examine factors influencing the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County, Kenya. The following study objectives guided the study: to examine how capital and credit facilities influence the adoption of agricultural technology among small holder farmers; establish how training influences the adoption of agricultural technology among small holder farmers; determine how availability of agricultural extension services influence the adoption of agricultural technology among small holder farmers; determine how market availability influences the adoption of agricultural technology among small holder farmers and establish how demographic characteristics of farmers influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County. Conceptual framework guided the study by illustrating how the various variables were interrelated. The study adopted an exploratory research design. The target population consisted of 25 producer groups having 25 small holder farmers (625 small holder farmers), five key producer group officials in each of the 25 producer groups (125 officials), 15 respondents from Kenya Agricultural Research Institute and 10 respondents from Bukura Agricultural Training College and the one respondent from the Ministry of Agriculture. Simple random sampling techniques was used to select 188 small holder farmers while purposive sampling techniques were used to select 125 key producer group officials,15 respondents from Kenya Agricultural Research Institute and 10 respondents from Bukura Agricultural Training College and one respondent from the Ministry of Agriculture. The questionnaires and interviews schedules were used to collect data. On validity of the instruments, the researcher used content validity while Cronbach Alpha Reliability coefficient value was 0.87. Data was analysed by use of both descriptive and inferential statistics and presented in frequency tables and measures of central tendency. Regression and correlation analyses were used to test levels of significance and strength of relationship among study variables. Qualitative data from the in-depth interviews was also analyzed and presented appropriately. Results of the study were: Capital and credit facilities had positive and significant association on the adoption of agricultural technology but at varying degrees; results indicated that training has a marginally positive and significant influence on the adoption of technologies among smallholder farmers. There was a marginal weak positive association between availability of agricultural extension services and adoption of agricultural technology. Results revealed that market availability has a positive and significant ($p<0.05$) on the adoption of agricultural technology and the farmers' educational levels, gender and age had positive and significant influence on the adoption of technology while the variable on males and females adopting technology equally had positive but insignificant influence. Therefore, the following recommendations were made: There is a need to increase farmers' capital and credit facilities and make these services accessible to the farmers. The farmers and extension officers ought to be trained on yield-raising technologies and fertility-restoring and conservation technologies and other technologies that can positively contribute to high productivity among farmers. The findings of this study may prove the need to improve living standards of farmers by upgrading their production capacity.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

In the past several years following the advent of the green revolution, concerted efforts to raise food production resulted in substantial increments in global food output. The distribution of the increase was heavily skewed towards the more developed nations while other regions of the globe realized less than impressive increments. Food output in Africa lags behind the rest of the world's production levels. In the last decade, the continent's share of world food production was a meager 3.9%. By comparison, Asia, North America and Europe produced 47.7%, 14.8% and 12.2% respectively (Oerke, Dehne, Schoenbeck and Weber, 1994). By 1990, Africa's population was 615 million and was projected to increase to 813 million by the end of 2002 (FAOSTAT, 2002), a 32% population increase in just over a decade. Moreover, even within Africa, there are variations in these trends with some countries exhibiting higher population growth with low agricultural development. Sub-Saharan Africa's agricultural performance has been variably called the world's foremost global challenge(United Nations, 1997) and as "still very far behind" the rest of Africa (Odulaja and Kiros, 1996 p.86). Moreover, the region's population is increasing, and is expected to account for30% of the underdeveloped world by the year 2010.

Technology is one of resources for agricultural production. According to Ingold (2002), definitions of technology differ widely, depending on whether the intent is to embrace the totality of human works, in all societies and during allepochs. Rogers (1983) reported that technology is a design for instrumental action that reduced the uncertainty in the cause and effect relationships involved in achieving a desired outcome.

Technology comprises of two components, hardware and soft-ware. The hardware consists of physical tool that embodies technology (Chi and Yamada, 2002). The software consists of information base for the tool. In Mumford's classification (1946), "technology–as–objects" encompasses the entire range of fabricated items intended for some use or other, including tools, utensils, utilities, apparatus and machines. Mitcham (1978), "technology–as–process", includes most importantly the activities we commonly denote as making and using. The key element here is that of skill defined as 'proficiency in the use of artefact'. Ingold (2002) distinguished technique from technology. Technique refers to skills, regarded as capability of particular human subjects, and technology means a corpus of generalized, objective knowledge, insofar as it is capable of practical application.

Farmers' changes of technology use are influenced by technical training, meeting, oral transmission, trust on technician and belief level on technology. The total environment can be divided into two elements: technology and human. Technology determines the type and physical potential of livestock enterprises, and includes the physical and biological factors that can be modified through technology development (Chi and Yamada, 2002).The human element is characterized by exogenous (community structures and external institution) and endogenous factors, which can be controlled by the farm household. At the center of this interaction is household member. The household ultimately decides on the farming systems on whether or not to adopt technologies and how to assign resources to support it (Norman, 1980, cited by Paris). The decision of use of technologies is dependent on how farmers perceive of technology. According to Price (1996), perception acts as filter through which new observations are interpreted. According to Van de Ban and Hawkin (1988), perception is the process by which we received information

Technology can be reached farmers through technology transfer. Technology transfer refers to the general process of moving information and skills from information or knowledge 'generators' such as research laboratories and universities to clients such as farmers (Valera *et al*., 1987).The outcome of new technology transfer is the farmers' adoption and bringing this into practice and further diffusion to other individuals in the community. Regarding to adoption, farmers sometimes discover problems in putting recommendation into practice, the extent of adoption, adjustment or rejection depends on farmers' behavior (Valera *et al*., 1987). Mosher(1987, cited by Cruz, 1978) defined that adoption of an innovation is the process by which a particular farmer is exposed to, considers and finally rejects or practices a particular innovation. The innovation decision model by Rogers (1983) shows the process through which an individual (or other decision making unit) passes from first knowledge of an innovation to forming an attitude towards the innovation, to a decision to adopt or reject, to implement of the new idea, and to confirmation of this decision.

There are number of factors that influence the extent of adoption of technology such as characteristics or attributes of technology; the adopters or clientele, which is the object of change; the change agent(extension worker, professional); and the socio-economic, biological, and physical environment in which the technology take place (Cruz, 1987).

Farmers have been seen as major constraint in development process(Cruz 1987). They are innovators or laggards. Socio-psychological trait of farmers is important. The age, education attainment, income, family size, tenure status, credit use, value system, and beliefs were positively related to adoption. The personal characteristics of extension worker such as credibility, have good relationship with farmers, intelligence, emphatic ability, sincerity, resourcefulness, ability to communicate with farmers, persuasiveness and development orientation. The biophysical environment influences the adoption. The conditions of the farm include its location, availability of resources and other facilities such as roads, markets, transportation, pests, rainfall distribution, soil type, water, services and electricity. For instance, farmers whose farms were irrigated were the earliest adopters of new rice varieties, while those without water were the late adopters. The innovation diffuses slowly if product price is low.

Chi and Yamada (2002) carried out a study in Japan on the factors affecting farmers' adoption of technologies in farming system. These researchers used Focused Group Discussions (FGDs) and established the following reasons for not adoption of technology: farmers did not believe because it was new to them; they have not yet seen the demonstration Fields; they worried of low yield, low education, old age farmers who did not believe new technology and only believe their own experience, old behavior of cultivation practices embedded in farmers for long period: were not persuaded to use new technology. They only practiced by their own practices such as using high rate of seeds in directly broadcasting and spraying pesticide for prevention of insect occurrence. Large land holding farmers, farmers were feeling that it is not so sure about new technologies; particularly to those farmers have large land. They said if the yield loss due to new technologies in larger field, the amount of loss will be greater. According to Lazaro *et al*. (1993), farmers usually overestimate the yield loss caused by insects rather than the actual loss.

Similarly, a study conducted by Muzari, Gatsiand Muvhunzi (2012)in Sub-Saharan Africa on the impacts of technology adoption on smallholder agricultural productivity found out that the factors affecting technology adoption were assets, income, institutions, vulnerability, awareness, labour, and innovativeness by smallholder farmers. They also established that technologies that require few assets, have a lower risk premium, and are less expensive have a higher chance of being adopted by smallholder farmers. There are certain traditional smallholder agricultural technologies in sub-Saharan Africa that also have their own merits. Some of these technologies are more efficient in their use of scarce production resources than modern technologies.

A study was carried out by Sulo, Koech, Chumo and Chepng'eno on the socioeconomic factors affecting the adoption of improved agricultural technologies among women in Marakwet County, Kenya. In this study, the sample represented all farmers targeted by the project giving information on socio-economic characteristics, age, education levels, extension services, education, household size and the number of the technologies adopted among others. Quantitative and qualitative data analysis methods were used to analyze explanatory variables in this study such as education levels, household size, level of income, age, contacts with extension agents, Access to extension facilities, membership to groups or associations. The results show that such factors such as primary occupation, annual income, household size and membership of women's group showed a positive and very significant relationship with the women adoption of agricultural technologies. From the findings the women ranked such constraints as lack of access to land, lack of capital and credit facilities, non-membership of women's group, non-provision of information by the agricultural officers on agricultural production technologies, ineffective extension services and coverage among others, as major hindrances to effective achievement of the set objectives of improving the socioeconomic wellbeing of women farmers

As part of Economic Recovery strategy (ERS, 2003-2007) the National Government of Kenya recommended promotion of technology adoption, improvement in food security, household incomes and creation of jobs with the funding of over 1.5 million shillings(Kakamega North District Annual Report, 2012) specifically directed to Kakamega North sub county through various programs such as National Accelerated Agricultural Inputs Access Program(NAAIAP) that was implemented in Kakamega North Sub-County in the financial year 210/2011, Njaa Marufuku Kenya program(NMK) and National Agriculture and Livestock Extension program(NALEP) implemented in the financial year 2012-2013/2013 - 2014 and is being transformed to Agriculture Sector (ASDSP). The primary objective of these programs is to improve technology specifically farm inputs (fertilizer and seeds) access and affordability for smallholder farmers to enhance food security/availability at the household level and generate incomes from sales of surplus produce.

1.2 Statement of the Problem

According to Kenya Population and Household Census of 2009, Kakamega North has a total land area of 427.4 km^2; it is one of the most densely populated Sub-County in Kakamega County with a total of 1,660,651 people. Eighty percent (80%) of the population in Kakamega North District primarily depends on agriculture for survival. The poverty levels are still significant about 30% together with farmers' ignorance, traditions and cultures lower adoption rates of agricultural technologies at 30% to 60% (Kakamega North District Annual Report, 2012). Most of these people depend on sugar production whose productivity has been below the expected standards. The Government of Kenya (2012) recommended promotion of technology adoption, improvement in food security, household incomes and creation of jobs with the funding of over 1.5 million shillings. A survey by Kenya Horticulture Competiveness Project (USAID Funded Project, 2013) has indicated that the adoption of agricultural technologies and subsequently food production in the County is low. Furthermore, it has also been revealed that the constraints that affect agricultural production in the Sub-County are: high cost of inputs (seeds, chemicals, and fertilizer); low technical knowhow on agronomy and operation of equipment; farmers rely on rain-fed agriculture and therefore, production follows a single trend; pests and diseases on crops and control are very expensive and there was no organized marketing channels for produce when in high supply. On the contrary, the technology/innovation rate of Lugari Sub-County stands at 80%, an indication that technology/innovation rate is higher compared to Kakamega North Sub-County (30-60%) (Sub-County Annual Report, 2013).There is therefore dire need to unearth the underlying reasons contributing to this low adoption of agricultural technologies and poor agricultural production leading to higher poverty levels.

1.3 Purpose of the Study

The purpose of this study was to examine factors influencing the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County, Kenya.

1.4 Research Objectives

The following research objectives guided the study:

1. To examine how capital and credit facilities influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.
2. To establish how training influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.
3. To determine how availability of agricultural extension services influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.
4. To determine how market availability influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.
5. To establish how demographic characteristics of farmers influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.

1.5 Research Questions

The study was guided by the following research questions:

1. How do capital and credit facilities influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County?
2. How does training influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County?
3. How doesavailability of agricultural extension services influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County?
4. What is the influence of market availability on the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County?
5. What is the influence of demographic characteristics of farmers on the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County?

1.6 Significance of the Study

Considering the fact that most farmers participate in agriculture in developing countries, this research on agricultural technology adoption is critical. This research will prove the need to improve living standards of farmers by upgrading their production capacity. Given that poverty levels of Kakamega North Sub-County stand at 80% and its technology/innovation at 30%-60%, this study will be integral in increasing adoption of technology and subsequent reduction in poverty. Therefore, the findings of this research will be helpful to farmers, academicians, researchers and the Ministry of Agriculture in assessing the underlying reasons contributing to the low adoption of agricultural technologies and poor agricultural production leading to higher poverty levels.

1.7 Delimitations of the Study

This study was carried out in Kakamega North Sub-County and focused on the factors influencing the adoption of agricultural technology among smallholder farmers in Kakamega North Sub-County, Kenya. The study employed questionnaires and interview schedules in data collection. All the 25 farmer producer groups containing 25 members in each group were targeted (625 smallholder farmers).

1.8 Limitations of the Study

The researcher encountered the following shortcomings: the study area had 625 smallholder farmers, indicating that reaching all these smallholder farmers was not be easy, hence a research assistants were used; the interviews that were used in the data collection had various advantages, but were regarded as time consuming and costly, therefore, the researcher overcame this by setting time frames within which the interviews were conducted to save time and reduce costs.

1.9 Assumptions of the Study

This study was be carried out with the following assumptions in mind: all the smallholder farmers were faced with challenges of technology adoption; the target respondents were co-operative and gave voluntarily, accurate information; extraneous factors not meant for study did not interfere with the main focus in this study (like government policies, culture and community cooperation). All respondents were honest and found appropriate time to respond to questionnaires. Lastly, target groups were not be affected by any disasters during the study for example, unrests, rainstorms and lightening.

1.10 Definitions of Significant Terms

Adoption: - refers to the decisions that individuals make each time that they consider taking up an innovation or decision of an individual to make use of an innovation as the best course of action available.

Educational Level: This refers to the primary, secondary, college and university levels of education of the respondents.

Culture: This refers to beliefs, values, customs, arts, social institutions. The specific collection of values and norms that are shared by people and groups in an organization and that control the way they interact with each other and with stakeholders outside the organization.

Integration is taken here to mean the incorporation into the management process.

Institutions: include all the services to agricultural development, such as finance, insurance and information dissemination. They also include facilities and mechanisms that enhance farmers' access to productive inputs and product markets. Institutions also include the embedded norms, behaviours and practices in society.

Technology: refers to how to cultivate a crop successfully. This success can be obtained by knowing how to apply fertilizer, control pests, and take care of plant for its healthy and good growing. Other definition is said that technology refers to what crop varieties and what kind of fertilizers that are suitable for the soil

1.11 Organization of the Study

This study was organized in five chapters. Chapter one describes the background to the study, statement of the problem, purpose of the study, the objectives, research questions, significance of the study, delimitation of the study, the limitations of the study, assumptions of the study, definition of significant terms used in the study and the organisation of the study. This chapter comprised of literature review that is relevant to the research topic like how capital and credit facilities, educational level, availability of agricultural extension services, training, market availability and demographic characteristics influence the adoption of agricultural technology among smallholder farmers. Chapter three consists of the research methods to be used in carrying out the study. It includes research design, location of study, target population, sampling procedures and sample size, research instruments, validity and reliability of research instruments, data collection procedures and data analysis techniques.

Chapter four consists of data analysis, presentation, interpretation and discussion and finally chapter five that consists of a summary of the conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter comprises literature review that is relevant to the research topic, and includes the empirical literature on the adoption of agricultural technology among small holder farmers; capital and credit facilities and adoption of agricultural technology; training and the adoption of agricultural technology; availability of agricultural extension services and the adoption of agricultural technology, marketing availability and the adoption of agricultural technology and demographic information and the adoption of agricultural technology. The aim of the literature review was to reveal the knowledge gaps which the study sought to fill in.

2.2 Adoption of Agricultural Technology among Small Holder Farmers

There is a widely held belief that traditional technologies and institutions are to blame for low agricultural productivity and food insecurity in the sub-Saharan African region (Mkandawire &Matlosa, 1993). There is the notion that “backward” peasants can only be made more productive and food secure through technological and institutional transfer from the North to the South, and from the modern sub-sector into the peasant sub-sector(Mkandawire &Matlosa, 1993). Many governments in the region still believe in the importation of western technologies and institutions, such as tractors, high analysis fertilizers, and modern seeds as well as in changing the prevailing customary land tenure arrangements (Mkandawire &Matlosa, 1993). Traditional technologies and tenure arrangements and other institutions are perceived as pseudo-scientific, backward, primitive, valueless, crude, mistaken, fallacious and a stumbling block to increased agricultural productivity (Mkandawire &Matlosa, 1993). Literature which favours large-scale modern agriculture tends to claim that if land were returned to traditional farmers, millions would starve to death (Innis, 1997). Traditional farmers, when they are presented in textbooks and analytical research papers, are portrayed as very “rigid” in their ways, unable and unwilling to respond to new ideas or opportunities (Innis, 1997).

Many observers are questioning why the Green Revolution which transformed agriculture in Europe and SouthEast Asia has not been able to achieve the same results in sub-Saharan Africa (Mkandawire &Matlosa, 1993).The majority of the victims of the agrarian crisis in the region are peasants living in rural areas. Peasants in this region may be worse off than they were in the 1960s (Mkandawire &Matlosa, 1993). The vast majority of the peasants and their families have become part of the cycle of poverty in Africa, and many of them are now unable to feed themselves (Mkandawire &Matlosa, 1993). There is a looming shadow of a food and agriculture crisis threatening millions of people in sub-Saharan Africa. For a continent in which more than 70% of the labor force ekes out a living from agriculture, the region is doubtless experiencing a deep-seated crisis of food production Mkandawire &Matlosa, 1993). Self-sufficient in production at independence, sub-Saharan Africa is now a net food importer (Mkandawire &Matlosa, 1993).

There is a large gap between what the smallholder farmer gets and what is feasible with the available technology in sub-Saharan Africa (Muhoho, 1989). In looking at what has gone wrong, a fundamental issue of concern relates to the technologies and institutional arrangements that are being promoted by governments in the region to increase agricultural productivity (Mkandawire &Matlosa, 1993). The use of agricultural technologies affects the rate of increase in agricultural output. It also determines how the increase in agricultural output impacts on poverty levels and environmental degradation (Meinzen-Dick et al., 2002). Therefore the focus of recent research has been to find better agricultural practices. New strains of crops have been discovered. The focus of research has also been on improvements of land, soil and water management practices (Meinzen-Dick *et al*.,2002). However, the only way for smallholder farmers to benefit from these research station technologies is if they perceive them to be appropriate and proceed to implement them on their farms (Meinzen-Dick *et al*., 2002).

Increased agricultural productivity, technology adoption rates, and household food security and nutrition can be achieved through improved agricultural practices, expansion of rural financial markets, increased capital and equipment ownership by rural households, and development of research and extension linkages (von Braun,1999). Increased technology development and adoption can raise agricultural output, hence improve household food intake. Improved food intake can also improve the functioning of the human body and the performance of a healthy, normal life which will increase work output. However, increased technology adoption may result in high labour demands and less time available for other household activities by women (e.g. household chores like child care, and fuel wood and water collection) (Kennedy &Bouis, 1993).

According to Bonabana-Wabbi (2002), there is an extensive body of literature on the economic theory of technology adoption. Several factors have been found to affect adoption. These include government policies, technological change, market forces, environmental concerns, demographic factors, institutional factors and delivery mechanism. Although not tested, it appears that only four of these broad items may be related to IPM technology adoption. They include market forces: availability of labor, technology resource requirements, farm size, level of expected benefits, and level of effort required to implement the technology; social factors: age of potential adopter, social status of farmers, education level and gender-related aspects, household size, and farming experience; management factors: membership to organizations, the capacity to borrow, and concerns about environmental degradation and human health of farmers; institutional/technology delivery mechanisms: information access, extension services, and prior participation in, and training in pest control practices.

Some studies classify the factors affecting adoption of technology into broad categories: farmer characteristics, farm structure, institutional characteristics and managerial structure (McNamara, Wetzstein and Douce, 1991) while others classify them under social, economic and physical categories (Kebede, Gunjal and Coffin 1990). Others group the factors into human capital, production, policy and natural resource characteristics (Wu and Babcock, 1998) or simply whether they are continuous or discrete (Shakya and Flinn, 1985). By stating that agricultural practices are not adopted in a social and economic vacuum, Nowak (1987)brought in yet another category of classification. He categorizes factors influencing adoption as informational, economic and ecological.

Much empirical adoption literature focuses on farm size as the first and probably the most important determinant. The effect of farm size has been variously found to be positive (Kasenge, 1998), negative (Yaron, Dinar and Voet, 1992) or even neutral to adoption (Mugisa-Mutetikka*et al*., 2000). Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labor requirements, tenure arrangements and more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara and Singh, 1993) especially if the technology requires a substantial amount of initial set-up cost, so-called "lumpy technology." In relation to lumpy technology, Feder, Just and Zilberman, (1985) further noted that only larger farms will adopt these innovations. With some technologies, the speed of adoption is different for small- and large- scale farmers. In Kenya, for example, a recent study (Gabre-Madhin and Haggblade, 2001) found that large commercial farmers adopted new high-yielding maize varieties more rapidly than smallholders.

One of the strategies for poverty reduction through increased agricultural productivity is to promote the production of high yielding crop varieties (Nkonya*et al*., 2004). Significant increases in crop production in sub-Saharan Africa can be achieved from improved and open-pollinated varieties developed with a comprehensive breeding system (Eberhart, 1989). The breeding should incorporate multi-sage selection for important agronomic traits such as disease resistance, insect resistance, drought and stress tolerance, high yield and high response to improved cultural practices (Eberhart, 1989). Farmers seek both risk avoidance and high yields in the hybrid and open pollinated varieties they select to grow. Hybrids can be expected to be the commercial product whenever conditions permit the production and sale of high quality hybrid seed (Eberhart,1989). Breeding strategies are being used by research organizations such as CIMMYT and ICRISAT to reduce the impact of drought stress, low nitrogen availability, Aluminium toxicity, diseases and insects in sub-Saharan Africa (Diallo *et al*., 1989).

The rate of investment in crop breeding targeted to rainfed environments is crucial to future crop yield growth (Rosegrant*et al*., 2002). Continued application of conventional breeding and recent developments innon-conventional breeding offer considerable potential for improved cereal yield growth in rainfed environments(Rosegrant*et al*., 2002). Cereal yield growth could be further improved by extending research downstream to farmers and upstream to the use of tools derived from biotechnology to assist conventional breeding (Rosegrant*et al*., 2002). It has been demonstrated in numerous experiments in sub-Saharan Africa that the performance of improved maize varieties is superior to the traditional varieties in most farmers' fields (Sitch*et al*., 1996). The yields of maize on smallholder farms are often limited because farmers do not have the improved seed varieties(Sitch*et al*., 1996).

One of the major limitations to crop productivity is the acute shortage of improved varieties (Fumo& De Vries, 1995).To improve productivity in the agricultural sector will, among other things, require a concerted effort in providing the farming community with high yielding varieties that are drought and pest resistant (Mazonde,1993). Higher crop yields, which lead to sustained development of the arable sector because they reduce costs per unit of output, should form a major technological challenge for sub-Saharan African countries (Mazonde, 1993).

The weed problem in smallholder agriculture is not just late weeding. Weed management is complicated by rainfall patterns and cultural practices which lead to a build-up of weeds, costly multiple weedings, and poor quality weeding (Mwania*et al*., 1989). In addition, the mode of seedbed preparation, onset of rains, intercropping, and labor or cash availability bear significance on the timing, quality and cost of weeding(Mwania*et al*., 1989). Firstly, smallholders do very few tillage operations, usually just one breaking, where weed seeds are shallow covered, thereby germinating easily (Mwania*et al*., 1989). Furthermore, smallholders usually preserve some volunteer plants which they use as vegetables, and these haphazardly growing plants affect weeding. Some farmers delay weeding deliberately to allow these vegetables to germinate, thus encouraging heavy growth of real weeds (Mwania *et al*., 1989).

Weed control is a widely adopted technology among smallholder farmers in sub-Saharan Africa (Bisanda &Mwangi, 1996). Most farmers use hand hoes for weeding, and a small minority use herbicides (Bisanda &Mwangi, 1996). Herbicide use in weed control is limited under smallholder farming systems. Smallholders have limited resources for the purchase of sprayers or herbicides and in addition water is not readily available(Mwania*et al*., 1989). Furthermore, use of herbicides requires skills and involves risks which peasant farmers cannot afford (Bisanda & Mwangi, 1996). Weeding of any intensity among smallholders will increase crop yields (e.g. for maize), but this could be conducted only once during the season to make more efficient use of scarce labor resources (Sitch*et al*., 1996). Although weeding results in significant productivity gains, survey and experimental results indicate that the extent of the benefit gained from weeding varies across seasons and locations (Sitch*et al*., 1996).

This study will attempt to address the factors influencing the adoption of agricultural technology among small holder farmers in which other previous studies did not address, to illustrate to what extent variables like capital and credit facilities training, availability of agricultural extension services, market availability and demographic characteristics of farmers influence the adoption of agricultural technology among small holder farmers in Kenya and particularly in Kakamega North Sub-County.

2.2.1 Capital and Credit Facilities and Adoption of Agricultural Technology

The decision to adopt is often an investment decision. And as Caswell *et al,* (2001) note, this decision presents a shift in farmers' investment options. Therefore adoption can be expected to be dependent on cost of a technology and on whether farmers possess the required resources. Technologies that are capital-intensive are only affordable by wealthier farmers (El Oster and Morehart, 1999) and hence the adoption of such technologies is limited to larger farmers who have the wealth (Khanna, 2001). In addition, changes that cost little are adopted more quickly than those requiring large expenditures; hence both extent and rate of adoption may be dependent on the cost of a technology. Economic theory suggests that a reduction in price of a good or service can result in more of it being demanded.

Institutional factors deal with the extent or degree to which institutions impact on technology adoption by smallholders (Meinzen-Dick *et al*., 2004). Institutions include all the services to agricultural development, such as finance, insurance and information dissemination. They also include facilities and mechanisms that enhance farmers' access to productive inputs and product markets. Institutions also include the embedded norms, behaviours and practices in society (Meinzen-Dick *et al*., 2004). Researchers and development practitioners should also consider issues that relate to the farmers' exposure to economic, agro-meteorological, biophysical and social shocks in designing technologies for smallholders. Care should be taken to avoid technologies with a high investment cost structure which smallholders cannot afford because they are poor and lack the necessary resources (Meinzen-Dick *et al*., 2004). Crop insurance can to some extent lessen the risk of farmers' exposure to external shocks (Meinzen-Dick *et al*., 2004).

Embedded norms, behaviours and practices in society can encourage or discourage adoption of a particular technology by members of that society (Meinzen-Dick *et al*., 2004). For example, the practice that the production of certain types of crops are the preserve of male members of society can limit the adoption of a particular technology in Sub-Saharan Africa if the crop to be promoted is grown mainly by men. This is because women constitute the majority of rural dwellers in this part of Africa. Clearly therefore, an understanding of local cultural practices and preferences is important if they are to benefit from agricultural research(Meinzen-Dick *et al*., 2004).

Results of studies in sub-Saharan Africa have shown that male headed households have more access to land, education, and information on new technologies (Bisanda & Mwangi, 1996). There is a strong association between the gender of the household head and adoption of technological recommendations (Bisanda & Mwangi,1996). In some countries female-headed households are discriminated against by credit institutions, and as such they are unable to finance yield-raising technologies, leading to low adoption rates (Mkandawire, 1993). There is clearly a case for improving current smallholder credit systems to ensure that a wider spectrum of smallholders are able to have access to credit, more especially female-headed households (Mkandawire, 1993). This may, in certain cases, necessitate designing credit packages that are tailored to meet the needs of specific target groups(Mkandawire, 1993).

The major option for increased adoption of technology is to overcome the income/ capital constraint through increased credit provision (Mkandawire, 1993). However, one of the most discernible features around credit inmost sub-Saharan African countries is the lack of an educational package linked to credit for small rural producers (Chidzonga, 1993).The cost of technology is a major constraint to technology adoption (Bisanda & Mwangi, 1996). The elimination of subsidies on prices of seed and fertilizers since the 1990s due to the World Bank-sponsored structural adjustment programs in sub-Saharan Africa has worsened this constraint (Chidzonga, 1993; Bisanda & Mwangi,1996; Nkonya *et al*., 1996; Akulumika *et al*., 1996).

Moreover, the cost of hybrid grain production is more than double the cost incurred in the production of maize under traditional practices (Seboka *et al*., 1996). In certain scenarios of different agro-ecological, input and product market conditions, it has been shown in profitability analyses that there is no economic advantage of growing hybrids without either minimum floor price guarantee after harvest, or support in post-harvest technologies (Seboka *et al.,* 1996). The evidence underscores the need for government intervention in promoting post-harvest technologies, credit, marketing and grain price support strategies (Seboka *et al*., 1996).

2.2.2 Training and the Adoption of Agricultural Technology

It is imperative that agricultural training and extension programmes be intensive enough to promote adoption not only of improved yield-raising technologies, such as improved seeds, but also of fertility-restoring and conservation technologies (Nkonya*et al*., 2004). Synergies need to be created between government departments, non-governmental organizations, researchers, donors and local communities in implementing programs that promote smallholder farmers' adoption of technologies which can increase agricultural productivity and reduce environmental degradation and the deterioration of soil quality (Rosegrant*et al*., 2002; Nkonya*et al*., 2004).

Major problems in sub-Saharan Africa is that year after year extension workers who are hardly afforded in-service training, and are loosely linked to research, continue to disseminate the same messages repeatedly to the same audience (Mkandawire, 1993). A situation has consequently arisen where the disseminated messages to the majority of the extension audience, have become technically redundant and obsolete (Mkandawire, 1993).

An additional problem is that most extension services tend to focus on the well-resourced, wealthier farmers and perceive farmers as simply agents of change (Mkandawire, 1993).

2.2.3 Availability of Agricultural Extension Services and the Adoption of Agricultural Technology

Additional constraints inhibiting increased fertilizer use among smallholders include lack of knowledge and ability to differentiate between various nutrient sources; and lack of understanding of cost-effective methods of soil fertility management (Mwania*et al*., 1989). It has also been found that income from off-farm sources is important in the financing of purchased farm inputs (e.g. seeds, fertilizers, labor) (Mwania*et al*., 1989). In addition, cash proceeds from crop sales, and income obtained from the sale of livestock and livestock products, also provide cash for the purchase of inputs in crop farming (Mwania*et al*., 1989). Higher levels of income from each of the above sources will lead to higher rates of adoption of yield-raising technology. Labor bottlenecks, resulting from higher labor requirements that new technologies often introduce, and seasonal peaks that may overlap with other agricultural activities, are important constraints to technology adoption (Meinzen-Dick *et al*., 2002).

Acquisition of information about a new technology demystifies it and makes it more available to farmers. Information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell *et al*., 2001). Exposure to information about new technologies as such significantly affects farmers' choices about it. Feder and Slade (1984) indicate how, provided a technology is profitable, increased information induces its adoption. However, in the case where experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it.

A good example is the adoption of recombinant bovine Somatotropin Technology (rbST) in dairy production (McGuirk, Preston and Jones, 1992; Klotz, Saha and Butler, 1995). Information is acquired through informal sources like the media, extension personnel, visits, meetings, and farm organizations and through formal education. It is important that this information be reliable, consistent and accurate. Thus, the right mix of information properties for a particular technology is needed for effectiveness in its impact on adoption.

Good extension programs and contacts with producers are a key aspect in technology dissemination and adoption. A recent publication stated that "a new technology is only as good as the mechanism of its dissemination" to farmers (IFPRI, 1995 p. 168). Most studies analyzing this variable in the context of agricultural technology show its strong positive influence on adoption. In fact Yaron, Dinar and Voet, (1992) show that its influence can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies.

2.2.4 Market Availability and Adoption of Agricultural Technology

Most of the maize in sub-Saharan Africa is grown by smallholder subsistence farmers (Hess, 1996). These farmers sometimes market part of their production (Hess, 1996). This group of farmers no doubt account for the major share of farmers who grow unimproved maize cultivars (Hess, 1996). These farmers are usually cash poor, if not resource poor in all respects (Hess, 1996). They are often located in ecological niches that are unique in one or more ways and often too small to justify the establishment of a scientifically based crop breeding program(Hess, 1996). Such farmers typically plant unimproved seed because it meets their needs without requiring the use of scarce or non-existent cash resources (Hess, 1996). Moreover, the local variety may meet their perceived grain quality or other needs better than other modern varieties available at any price (Hess, 1996). Such farmers frequently select the best ears from their harvest and use the seed for planting the next season (Hess, 1996).

Profitability varies with weather, price, and other shocks. The expected profitability of a technology considers the full range of these variable conditions. Expected profitability also varies spatially, with microclimates or distance from urban centers. Individual or household preferences will also affect the perceived benefits from adoption, which may vary within the household. For example, productivity increases due to the introduction of high-yield varieties have been successful in ecologically favorable areas but have often bypassed smallholders on marginal land (Almekinders and Hardon, 2006). While well off farmers are able to correct unfavorable micro-environments through inputs such as irrigation and fertilizer, poorer farmers are not. The profitability of highly sensitive technologies will be affected by the characteristics of the individual adopter, the microclimate and other variable factors (Evenson and Westphal, 1995). The fact that a technology is profitable in some circumstances does not mean that it should be adopted by all farmers. For example, rates of return to improved crop varieties are often high on experimental plots but may not be uniformly positive across farmers or plots (Suri, 2009). Official sources of information are often developed in response to conditions on test plots, and may therefore deliver instructions for cultivation that are inappropriate for some farmers (Duflo*et al*., 2008).

Individual preferences around product attributes, including taste and cultivation practices, will affect how profitability is perceived by the household. This is particularly true of production for home consumption. Farmer perceptions of technology attributes, such as ease of preparation and cooking, have been linked directly to adoption outcomes (Adesina and Akinwumi, 1993). Technologies imported from other regions may have different flavors and textures than local substitutes and may not be adopted even if they increase yields and income (Gafsi and Roe, 1979). Evidence shows that low income consumers in the developing world are willing to trade off substantial caloric intake for preferred foods (Atkin, 2012). Preferences, and therefore perceived profitability, are also shaped by social context, and norms around food and agriculture may guide aggregate adoption patterns (Bardhan and Udry, 1999). Social norms are relevant for technologies where individual adoption decisions generate costs and benefits from both the profitability of the technology and the possibility of social sanction (Munshi and Myaux, 2006).

Though a technology may be profitable for a household as a whole, within the household, costs and benefits of adoption may not be equally distributed. Evidence from models of intra-household decision making suggests that the household is not always the correct unit of analysis for understanding technology adoption. Constraints may differ among individuals within the household (Duflo and Udry, 2004). In particular, gender affects access to labor, land, and other important inputs for production, and may also affect preferences around production processes and outputs (Doss, 2001). Gender roles and dynamics are likely to be locally specific, so approaches that benefit women in one setting may have no effect in other settings. The distributional consequences of new technologies are therefore difficult to predict. Once women are able to overcome their disproportionately high resource constraints, they may be at least as likely to adopt agricultural technologies that are appropriate for them (Kumar, 1994).

2.2.5Demographic Characteristics of Farmers and Adoption of Agricultural Technology

Age is another factor thought to affect adoption. Age is said to be a primary latent characteristic in adoption decisions. However there is contention on the direction of the effect of age on adoption. Age was found to positively influence adoption of sorghum in Burkina Faso (Adesiina and Baidu-Forson, 1995), IPM on peanuts in Georgia (McNamara, Wetzstein, and Douce, 1991), and chemical control of rice stink bug in Texas (Harper *et al.*, 1990). The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. In addition, since adoption pay-offs occur over a long period of time, while costs occur in the earlier phases, age (time) of the farmer can have a profound effect on technology adoption.

However age has also been found to be either negatively correlated with adoption, or not significant in farmers' adoption decisions. In studies on adoption of land conservation practices in Niger (Baidu-Forson, 1999), rice in Guinea (Adesiina and Baidu-Forson,1995), fertilizer in Malawi (Green and Ng'ong'ola, 1993), IPM sweep nets in Texas (Harper*et al.*, 1990), Hybrid Cocoa in Ghana (Boahene, Snijders and Folmer, 1999), age was either not significant or was negatively related to adoption.

Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method. In addition, farmers' perception that technology development and the subsequent benefits, require a lot of time to realize, can reduce their interest in the new technology because of farmers' advanced age, and the possibility of not living long enough to enjoy it (Caswell *et al.*, 2001; Khanna,2001). Furthermore, elderly farmers often have different goals other than income maximization, in which case, they will not be expected to adopt an income-enhancing technology. As a matter of fact, it is expected that the old that do adopt a technology do so at a slow pace because of their tendency to adapt less swiftly to a new phenomenon(Tjornhom, 1995).

Studies in some areas have shown that smallholder farmers do not adopt all components of "packaged" technologies (Nguluu*et al.*, 1996). When exposed to innovations, smallholder farmers only take those components that they perceive as useful and economically within their reach (Nguluu*et al.*, 1996). Those that require a substantial cash outlay are not taken up easily (Ockwell et al., 1991). There are also technologies that do not require high investment costs and still exhibit low adoption. Rukandema (1984) and Muhammad and Parton (1992) have described other socio-economic factors such as farmers' innovativeness, age, off-farm income, risk and uncertainty that may result in low technology uptake. Lack of awareness of improved practices is another reason, particularly in remote areas (Nguluu*et al*., 1996). Other farmers do not adopt fertilizer use because they believe their farms are still fertile (Nguluu*et al*., 1996).

Studies that have sought to establish the effect of education on adoption in most cases relate it to years of formal schooling (Tjornhom, 1995, Feder and Slade, 1984). Generally education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Waller*et al*. 1998; Caswell *et al*., 2001). IPM is frequently stated to be a complex technology(Pimentel, 1986; Boahene, Snijders and Folmer, 1999). What is more, adoption literature(Rogers 1983) indicates that technology complexity has a negative effect on adoption.

However, education is thought to reduce the amount of complexity perceived in a technology thereby increasing a technology's adoption. According to Ehler and Bottrell(2000), one of the hindrances to widespread adoption of IPM as an alternative method to chemical control is that it requires greater ecological understanding of the production system. For IPM, the relevance of education comes to play in a number of ways. First, effective IPM requires regular field monitoring of pests conditions to identify the critical periods for application of a pesticide or other control measures (Adipala*et al*, 1999).Farmers' knowledge of insect life cycles is also crucial when precision is required about the best stage of the life cycle to apply a particular control strategy. In addition, knowledge of the possible dangers from improper use of particular practices may direct farmers to the safest application procedure regarding a given control strategy especially where chemicals are involved.

In recent studies reviewed, including Daku (2002) and Doss and Morris (2001), education positively affected IPM adoption. A study on IPM practices on potatoes identified level of education as one of the major factors that positively affected the observed level of IPM practices with Ohio potato growers (Waller et al, 1998). However, in adoption of IPM insect sweep nets in Texas, higher education was negatively related to adoption (Harper *et al*., 1990).

Gender issues in agricultural production and technology adoption have been investigated for a long time. Most show mixed evidence regarding the different roles men and women play in technology adoption. In the most recent studies, Doss and Morris (2001) in their study on factors influencing improved maize technology adoption in Ghana and Over field and Fleming (2001) studying coffee production in Papua New Guinea show insignificant effects of gender on adoption. The latter study notes “effort in improving women’s working skills does not appear warranted as their technical efficiency is estimated to be equivalent to that of males” (p.155). Since adoption of a practice is guided by the utility expected from it, the effort put into adopting it is reflective of this anticipated utility. It might then be expected that the relative roles women and men play in both ‘effort’ and ‘adoption’ are similar, hence suggesting that males and females adopt practices equally.

2.3 Theoretical Framework

This study was anchored on the Innovation Diffusion Theory advanced by Rogers (1995). Diffusion is defined as the process by which an innovation is adopted and gains acceptance by members of a certain community. Professionals in a number of disciplines, from agriculture to marketing, have used this theory to increase the adoption of innovative products and practices. There are a number of factors interacting to influence the diffusion of an innovation. The four major factors are the innovation itself, how information about the innovation is communicated, time, and the nature of the social system into which the innovation is being introduced (Rogers, 1995).By better understanding the multitude of factors that influence adoption of innovations, instructional technologist will be better able to explain, predict and account for the factors that impede or facilitate the diffusion of their products. In this study, diffusion is viewed to occur over time and can be seen as having five distinct stages, namely, Knowledge, Persuasion, Decision, Implementation, and Confirmation. According to this theory, potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation, and confirm (reaffirm or reject) the decision to adopt the innovation. In this study, capital and credit facilities, non-provision of information by the agricultural officers on agricultural production technologies (availability of agricultural extension services), marketing availability and demographic factors were regarded to be factors that affect the adoption of technologies among small scale farmers in Kakamega North Sub-County.

2.4 Conceptual Framework

Movement away from this ideal creates constraints on the adoption of even profitable technologies. This study sought to establish the factors that affect adoption of agricultural technology among smallholder farmers in Kakamega North Sub-County. This study was guided by the conceptual framework in Figure 1. This study was limited to the following factors: capital and credit facilities, non-provision of information by the agricultural officers on agricultural production technologies (availability of agricultural extension services), marketing availability and demographic factors which were independent variables and it was hypothesized that these variables have a positive and direct influence on the adoption of technologies among small scale farmers in Kakamega North Sub-County. This relationship was moderated by factors such as government policies and community cooperation. The directions of the arrows show the interrelationships between the key variables of the study.

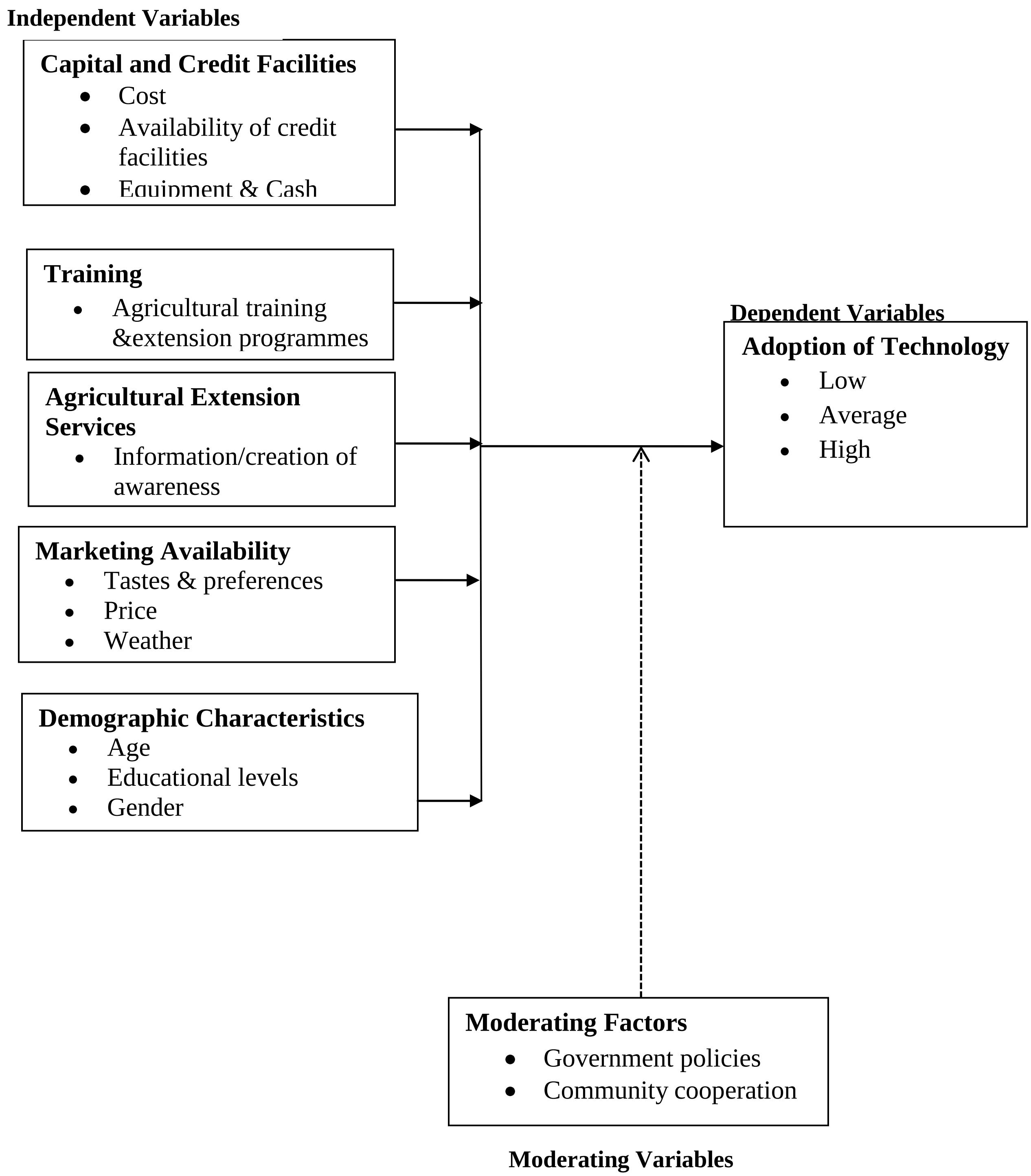

Figure 1: Conceptual Framework showing Interrelationships between Key Variables of the Study

Source: Researcher (2013)

2.5 Knowledge Gaps

A survey by Kenya Horticulture Competiveness Project (USAID Funded Project, 2013) indicated that the adoption of agricultural technologies and subsequently food production in the County is low. Most of these studies were carried out in developed economies, though focused on the factors affecting adoption of technologies among farmers. For example, Chi and Yamada (2002) carried out a study in Japan on the factors affecting farmers' adoption of technologies in farming system. Therefore, this study sought to examine factors influencing the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County, Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter on research design and methodology has the following sub-topics: research design, study location, target population, sample and sampling procedure, research instruments, validity and reliability, procedure for data collection, data analysis and ethical consideration.

3.2 Research Design

This study adopted an exploratory research design, which involves qualitative and quantitative data. This design was suitable for this study since it sought to provide insights and understanding of the factors influencing the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County. This study also sought to test specific hypotheses and examine relationships as captured in the sub-section 1.4 of the research objectives. A research design is a framework or blueprint for conducting the marketing research project. It details the procedures necessary for obtaining the information needed to structure or solve marketing research problems (Rofianto, 2012).

3.3 Target Population

The target population consisted of 25 producer groups having 25 small holder farmers (625small holder farmers), five key producer group officials in each of the 25 producer groups (125 officials), 15 respondents from Kenya Agricultural Research Institute and 10 respondents from Bukura Agricultural Training College and the one respondent from the Ministry of Agriculture (Kakamega North District Annual Report, 2012).

3.4 Sample Size Determination and Sampling Procedure

This section presents how the sample size was determined and the sampling procedure adopted by the study.

3.4.1 Sample Size Determination

Kakamega North Sub-County has 25 producer groups each having 25 small holder farmers. Therefore, all the 125 officials from 25 producer groups were used, forming a census study. The study also targeted the key informants from the research institutions (15 respondents from Kenya Agricultural Research Institute and 10 respondents from Bukura Agricultural Training College) and the one respondent from the Ministry of Agriculture who had understanding on factors influencing the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.

Best and Khan (2003), recommend a sample size of 20 per cent to 30 per cent ideal for proving reliable data when selected through random sampling. Therefore, in this study, the number of small holder farmers was randomly selected on the basis of 30 per cent as recommended by Best and Khan (2003):

$30/100 \times 625 = 187.5 \simeq 188$ small holder farmers who were proportionately apportioned in the 25producer groups.

3.4.2 Sampling Procedures

The simple random sampling was used to select 188 small holder farmers so that each and every one in the target population has an equal chance of inclusion (Kothari, 2003).The 125 officials from 25 producer groups, 15 respondents from Kenya Agricultural Research Institute and 10 respondents from Bukura Agricultural Training College and the one official from the Ministry of Agriculture were selected by purposive sampling technique.

Stratified random sampling procedure was used to categorize target population into small holder farmers, Kenya Agricultural Research Institute, Bukura Agricultural Training College and Ministry of Agriculture. This procedure is an important approach because it avoids mix up of certain parameters that are important in the study (Orodho, 2000).

3.5 Data Collection Instruments

This study adopted Questionnaires and interviews schedules to collect primary data.

3.5.1 Questionnaires for Key Informants

Questionnaires were useful instrument of collecting the primary data since the respondents can read and then give responses to each item and they can reach a large number of subjects (Orodho, 2004). The questionnaires for the respondents' from 125 officials of 25 producer groups, Kenya Agricultural Research Institute, Bukura Agricultural Training College and one official from the Ministry of Agriculture had two sections. Sections A sought to address general background information. Section B consisted of questions related to on the factors influencing the adoption of agricultural technology among small holder farmers (see Appendix 2).

3.5.2 Interview Schedules for Small Holder Farmers

The interview schedules were administered to the small holder farmers based on their varied educational levels. The interview schedules make it possible to obtain data required to meet specific objectives of the study (Mugenda and Mugenda, 1999). It also helps to standardize the interview such that the interviewer can ask the same questions in the same manner. According to Drew, Hardman and Hart (1996), the advantage of the interview techniques is that it enables the participants to enlighten the researcher about unfamiliar aspects of the setting and situation (see Appendix 3).

3.6 Validity and Reliability of Instruments

Pilot study was conducted to determine validity and reliability of research instruments.

3.6.1 Pilot Testing of Instruments

A pilot study is a standard scientific tool for 'soft' research, allowing scientists to conduct a preliminary analysis before committing to a full-blown study or experiment. A pilot, or feasibility study, is a small experiment designed to test logistics and gather information prior to a larger study, in order to improve the latter's quality and efficiency. A pilot study can reveal deficiencies in the design of a proposed experiment or procedure and these can then be addressed before time and resources are expended on large scale studies (NC3Rs, 2006).

3.6.1 Validity

According to Mugenda and Mugenda (2002) validity refers to the accuracy and meaningfulness of inferences made based on results obtained. It is asking a relevant question framed in the least way. White (2005) describes validity as the agreement between the researcher's conclusion and the actual reality. The researcher adopted the content validity to measure the validity of the instruments to be used. Content validity enables data being collected to be reliable in representing the specific content of a particular concept. Supervisors and the research experts from extra mural centre of Kakamega were used to evaluate the applicability and appropriateness of the content, clarity and adequacy of the research instrument from a research perspective. Validity was also checked during piloting to ensure all the items to be in the main study are functioning. Moreover, to ensure validity of the instruments, content validity was established from the pretest and re-test method that was done before the actual research. The pre-test retest was done in an area within the study location. This area was avoided during the actual research undertaking.

3.6.2 Reliability

According to Mugenda and Mugenda (1999), reliability of an instrument is a measure of the extent to which a research instrument yields consistent results or data after repeated trials in the study. The consistency of questionnaire was established through test pre-test method where research tools were administered twice to the same people under identical conditions, this procedure revealed the questions that were vague that could lead to respondents interpreting them differently hence adjustments accordingly. Reliability measured the relevance and correctness of the instruments (Mugenda and Mugenda, 2002). After piloting, the internal consistence procedure was used to determine the reliability of the instruments. This was determined from scores obtained from a single test administered to a sample of subject. A score obtained in one item was correlated with scores obtained from other items in the instrument. Finally, Cronbach Alpha Reliability coefficient value was computed and gave a value of 0.87. This value was higher than 0.7, the threshold set by Fraenkel and Wallen, (2000) and Mugenda and Mugenda (2003). On the basis of the results of piloting process, the instruments were then duly modified to meet performance standards before being used for the actual data collection.

3.7 Data Collection Procedures

The researcher sought permission from the University of Nairobi so as to be granted a permit from National Commission for Science Technology and Innovation (NACOSTI) to carry out the research. The researcher pre-tested the 10 producer groups, Kenya Agricultural Research Institute, Bukura Agricultural Training College and one official from the Ministry of Agriculture to book appointments with the relevant authorities. The research instruments were then administered by the researcher.

3.8 Methods of Data Analysis

Data analysis is examining the raw information collected during research investigation (Kombo and Tromp, 2006). This involved extracting of vital variables and scrutiny of collected information to establish faults. Raw data was sorted, coded and entered into Statistical Package for Social Sciences (SPSS) version 19.0 for Windows. Data was analysed by use of both qualitative and quantitative techniques. Quantitative data was analysed by use of descriptive statistics presented in frequency tables, and measures of central tendency. Regression and correlation analyses were used to test levels of significance and strength of relationship among study variables. Qualitative data from the in-depth interviews and focused group discussion was also analyzed and presented according to study objectives.

3.9 Ethical Considerations

Ethical considerations protect the rights of participants by ensuring confidentiality. It is unethical for the researcher to share identifying information regarding the study with anyone not associated with this study. This ethical consideration is necessary to maintain the integrity of the study as well as the integrity of the researcher (Creswell, 2002).The respondents were assured of the confidentiality of information given and were informed that their views will be used for the purpose of research only. The research findings were shared with the respondents involved in the study only (Mugenda and Mugenda, 2003).

3.10 Operational Definition of Variables

This section looks at the operational definition of variables as shown in Table 3.1.

Table 3.1: Operational Definition of Variables

Research Objectives	**Independent Variables**	**Dependable Variable**	**Statistical Tools**
1. To examine how capital and credit facilities influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.	Capital & credit facilities	Adoption of agricultural technology	Descriptive statistics, regression analysis
2. To establish how training influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.	Training	Adoption of agricultural technology	Descriptive statistics, regression analysis
3. To determine how availability of agricultural extension services influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.	Availability of agricultural extension services	Adoption of agricultural technology	Descriptive statistics, regression analysis
4. To determine how market availability influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.	Market availability	Adoption of agricultural technology	Descriptive statistics, regression analysis
5. To establish how demographic characteristics of farmers influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County	Demographic characteristics of farmers	Adoption of agricultural technology	Descriptive statistics, regression analysis

3.11Summary

This chapter covers the research methods to be used in carrying out the study. It includes research design, target population, sampling procedure which looks at the various sampling techniques, data collection instruments contains questionnaires, interview schedules, validity and reliability of research instruments included pilot testing and methods of data analysis.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

This chapter presents analysis of results based on the five objectives of the study. These were: to examine how capital and credit facilities influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County; to establish how training influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County; to determine how availability of agricultural extension services influence the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County; to determine how market availability influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County and to establish how demographic characteristics of farmers influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County.

4.2 Questionnaire Return Rate

This study distributed 151 questionnaires of which 144 were returned, representing 96%.Based on Kothari (2003) a return rate of this percentage is deemed adequate. Therefore, 96% questionnaire return rate was representative enough. In survey research response rate (also known as completion rate or return rate) refers to the number of people who answered the survey divided by the number of people in the sample. It is usually expressed in the form of a percentage.

4.3 Socio-Demographic Characteristics of the Respondents

This section discusses both social and demographic characteristics of the respondents based on age, gender, work experience and educational levels.

4.3.1 Age

The study sought to find out the age brackets of the key respondents in Kakamega North Sub-County by asking them to state their age ranges. This was to help determine the age distribution for the respondents. The results are shown in Table 4.1.

Table 4.2: Age Distribution of Respondents

Age distribution in years	Frequency	%
20-29 years	78	54.2
30-39 years	13	9.0
40-49 years	53	36.8
Total	**144**	**100.0**

Results show that the majority of respondents were in the age brackets of 20-29 years 78(54.2%), 30-39 years 13(9%) and 40-49 years had 53(36.8%). There was a significant difference among respondents in the age distribution since expected uniform distribution across age groups was not achieved in each age bracket. This meant that majority of the respondents were mature middle age people. This was an indication that the respondents had varied age distribution and therefore gave different views on the factors influencing the adoption of agricultural technology among smallholder farmers in Kakamega North Sub-County.

4.3.2 Gender

The study sought to find out the gender distribution among the key respondents in Kakamega North Sub-County. The respondents were asked to indicate their gender, this was done in order to assess if gender had any influence in the adoption of agricultural technology, the findings are shown in Table 4.2.

Table 4.3: Gender of Respondents

Gender	Frequency	%
Male	104	72.2
Female	40	27.8
Total	**144**	**100.0**

According to the results, majority of the respondents were males 104(72.2%) while the rest were females 40(27.8%). The results illustrated that there was a significant ($p<0.05$) variation in the gender distribution among the respondents since the expected 50% was not attained because the number of males was more than that of females who participated in the study. Therefore, gender equity among the respondents who participated in this study was not achieved. This could also point out that more males work who were officials of producer groups, Kenya Agricultural Research Institute, Bukura Agricultural Training College) and the Ministry of Agriculture than women in Kakamega North Sub-County.

The finding is true to what World Bank (1998) report on overall status of women in Africa says. Women's participation in national educational systems is again biased due to the socio-cultural and economic environments. There is also a lack of genuine political will to ensure that girls are given equal access to education in Africa. More than two-thirds of Africa's illiterates are women. Women are regarded as inferior to men and are not expected to aspire as high as men, especially in what are considered as 'male' fields (engineering, computing, architecture, medicine and others). It is largely assumed that educating women would make them too independent; in other words, they would not do what they are expected to do - look after the house, bring up children, and cater to their husband's needs.

4.3.3 Working Experience

The study sought to find out the experience of the respondents this was aimed at determining the number of working years and in turn know how much experience the respondents had been exposed to regarding the factors influencing the adoption of agricultural technology among smallholder farmers. The results are shown in Table 4.3.

Table 4.4: Working Experience of Respondents

Years	Frequency	%
Less than 5 years	91	63.2
5-10 years	13	9.0
10-15 years	29	20.1
Above 15 years	11	7.6
Total	**144**	**100.0**

The results illustrate that 91(63.2%) of the respondents have been working for less than 5 years, 13(9%) working for 5-10 years, 29(20.1%) for 10-15 years and those above 15 years were represented by 11(7.6%). This indicated that most respondents had acquired some experience, knowledge and skills to varying degrees to understand how the various factors affect the adoption of agricultural technology among smallholder farmers. The results seem to indicate that experience, knowledge, competencies and skills increase with increase in years of performing the job.

4.3.4 Educational Level

The study sought to find out formal educational levels of the key respondents in Kakamega North District. The respondents were asked to state their formal educational levels.

Table 4.5: Educational level of Respondents

Educational level	Frequency	%
Diploma	41	28.5
Bachelor’s degree	81	56.3
Masters	22	15.2
Total	**144**	**100.0**

The results are recorded in Table 4.4. Results show that 28.5% of respondents had diploma educational level, 56.3% had bachelor’s degree education level and 15.2% of respondents had masters’ degrees. There was a significant ($p<0.05$) difference in the levels of respondents’ education, an indication of respondents’ different understanding of how the various factors affect the adoption of agricultural technology among smallholder farmers. This correlates with Gem (2004) survey findings that education plays a pivotal role in the survival of the organisation and therefore employees should be exposed to various educational programmes to enable them to acquire knowledge in their respective endeavours. Results of studies in sub-Saharan Africa have shown that male headed households have more access to land, education, and information on new technologies (Bisanda & Mwangi, 1996).

4.4Influence of Capital and Credit Facilities on Adoption of Agricultural Technology

This section focuses on capital and credit facilities influence the adoption of agricultural technology. This was the first objective of the study. The results are tabulated in Table 4.5.

Table 4.6: Capital and Credit Facilities on Adoption of Agricultural Technology

Variables	**SA %**	**A %**	**U %**	**D %**	**SD %**
Cost of technology	64(44.4)	62(43.1)	18(12.5)	0.0	0.0
Availability of tools and equipment	87(60.4)	46(31.9)	11(7.6)	0.0	0.0
Availability of cash	75(52.1)	58(40.3)	0.0	4(2.8)	7(4.9)
Availability of credit facilities like soft loans	92(63.9)	18(12.5)	6(4.2)	28(19.4)	0.0
Exposure to technology	81(56.3)	35(24.3)	0.0	10(6.9)	18(12.5)

n = 144; Key: SA = strongly agree, A = agree, U = undecided, D = disagree and SD = strongly disagree

From the results, the respondents gave different views. For example, 87.5% of respondents indicated that the cost of technology was a very strong factor affecting adoption of technology among small holder farmers and 12.5% were undecided. Majority of respondents (92.3%) were of the opinion that the availability of tools and equipment was also a significant factor affecting adoption of technology. Ninety two point four percent (92.4%) of respondents expressed their views availability of cash determines whether technology will be adopted or not while only 7.7% of these respondents disagreed. On the exposure of small holder farmers to technology, 56.3% of respondents strongly agreed, 24.3% agreed, 6.9% disagreed while 12.5% strongly disagreed.

The study also carried out regression analysis between capital and credit facilities and the adoption of agricultural technology. The findings based on these factors are summarized on Table 4.6.

Table 4.7: Capital and Credit Facilities on Adoption of Agricultural Technology

Variables	Regression coefficient, b	Pearson Correlation Coefficient, r	t-test
Cost of technology	2.54	0.344*	1.090 (0.000) (s)
Availability of equipment and tools	1.32	0.226*	0.578(0.024) (s)
Availability of cash	1.34	0.233*	0.654 (0.000) (s)
Availability of credit facilities like soft loans	2.35	0.316*	1.020(0.008) (s)
Exposure to technology	1.15	0.279**	0.514(0.002) (s)
Overall Value	**1.738**	**0.280**	**0.771**

Constant/predictor variable: Capital and Credit Facilities

Dependent Variable: Adoption of Agricultural Technology

n= 144; s-significant; ns-not significant; ** *Correlation is significant at the 0.01 level (2-tailed;* * *Correlation is significant at the 0.05 level (2-tailed). p-value for correlation coefficients are in parentheses.*

Regression analysis revealed that capital and credit facilities had positive and significant association on the adoption of agricultural technology but at varying degrees, an indication that there was a moderate association between the capital and credit facilities and adoption of agricultural technology.

Research findings from the interviews of smallholder farmers also indicate that adoption of technology adoption among smallholder farmers is adversely affected by the age, education attainment, income, family size, tenure status, credit use, value system, and beliefs. The respondents also reiterated that cost of technology and exposure to technology were rated as the key determinants of technology adoption.

Cruz (1987) also confirmed that technology adoption was dependent on the characteristics or attributes of technology; the adopters or clientele; the change agent (extension worker, professional); and the socio-economic, biological, and physical environment in which the technology take place (Cruz, 1987). Cruz also observed that farmers themselves have been seen as major constraint in development process. They are innovators or laggards. Socio-psychological trait of farmers is important. The study findings were in conformity with what Chidzonga (1993) and Bisanda & Mwangi (1996) observed that one of the most discernible features around credit in most sub-Saharan African countries is the lack of an educational package linked to credit for small rural producers and that the cost of technology is a major constraint to technology adoption.

4.5Influence of Training on Adoption of Agricultural Technology

This section looks at how training affects adoption of technology among smallholder farmers. The results are illustrated in Table 4.7. This was the second objective of the study. From the results, 45% of respondents strongly agreed that farmers are trained on agricultural technology, 25% agreed, 9% of respondents were undecided while 21% of the respondents disagreed. It was also indicated that 58% of respondents were of the views that farmers are trained on improved yield-raising technologies, such as improved seeds, 6% were undecided and 36% of respondents disagreed. Further the results indicate that 55% of respondents indicated that farmers are trained on how to use variety of tools and equipment, 14% of respondents were undecided while 31% of respondents disagreed. Majority (61%) of the respondents were of the views that extension workers undergo in-service training, 11% were undecided while 31% of respondents indicated that these extension workers are not trained. Findings from interviews suggested that the extension workers continue to disseminate the same messages repeatedly to the same audience and the information given is obsolete and outdated.

Table 4.8: Influence of Training on Adoption of Agricultural Technology

Skills	**SA %**	**A %**	**U %**	**D %**	**SD %**
Training of farmers on agricultural technology	45.0	25.0	9.0	11.0	10.0
Farmers are trained on improved yield-raising technologies, such as improved seeds	55.0	3.0	6.0	5.0	31.0
Farmers are trained on how to use variety of tools and equipment	23.0	32.0	14.0	9.0	22.0
Extension workers undergoin-service training	38.0	23.0	11.0	18.0	13.0

n = 144; Key: SA = strongly agree, A = agree, U = undecided, D = disagree and SD = strongly disagree

Results from the interview schedules show that the smallholder farmers are poorly trained on the yield-raising technologies and that the extension workers tend to focus on the well-resourced, wealthier farmers leaving poor workers unattended to and that the farmers were not adequately trained on fertility-restoring and conservation technologies.

Table 4.9: Influence of Training on Adoption of Agricultural Technology

Variables	Pearson Correlation Coefficient, r
Training of farmers on agricultural technology	0.345**(0.000) (s)
Farmers are trained on improved yield-raising technologies, such as improved seeds	0.226* (0.024) (s)
Farmers are trained on how to use variety of tools and equipment	0.127** (0.000) (s)
Extension workers undergo in-service training	0.166** (0.008) (s)
Overall Value	**0.2004**
Constant/predictor variable: Training	
Dependent Variable: Adoption of Agricultural Technology	

n= 144; s-significant; ns-not significant; ** *Correlation is significant at the 0.01 level (2-tailed;* * *Correlation is significant at the 0.05 level (2-tailed). p-value for correlation coefficients are in parentheses.*

The correlation results show that training has a positive and significant influence on the adoption of technologies among smallholder farmers, though the degree of adoption of technologies is low signified by low r-values (r<0.5). Mkandawire (1993) observed that the services of the extension workers was not ineffective since the disseminated messages to the majority of the smallholder farmers have become technically redundant and obsolete and it does not keep with modern advancement in technology.

4.6Influence of Availability of Agricultural Extension Services on Adoption of Agricultural Technology

This section looks at the availability of agricultural extension services and how it has affected adoption of technology among smallholder farmers in Kakamega North Sub-County. This was the third objective of the study. The results of this objective are shown in Tables 4.8 and 4.9.

Table 4.10: Availability of Agricultural Extension Services on Adoption of Agricultural Technology Plan

Variables	SA %	A %	U %	D %	SD %
Small holder farmers are aware of yield-raising technologies, such as improved seeds	34.0	36.0	7.0	15.0	9.0
Small holder farmers are aware of fertility-restoring and conservation technologies	42.0	12.0	3.0	30.0	13.0
Extension officers are always available to give farmers updated information on technologies	18.0	6.0	8.0	35.0	33.0
In-service of training is conducted for small holder farmers	37.0	29.0	6.0	19.0	10.0

n = 144; Key: SA = strongly agree, A = agree, U = undecided, D = disagree and SD = strongly disagree

Results indicate that small holder farmers receive training on yield-raising technologies, such as improved seeds (34% of respondents strongly agreed, 36% agreed, 7% were undecided, 15% disagreed while 9% strongly agreed). On the question asked whether Small holder farmers are aware of fertility-restoring and conservation technologies, respondents gave varied responses (42% of respondents strongly agreed, 12% agreed, 3% were undecided, 30% disagreed while 13% strongly agreed). Mixed responses were also given on the question asking whether extension officers are always available to give farmers updated information on technologies (18% of respondents strongly agreed, 6% agreed, 8% were undecided, 35% disagreed while 33% strongly disagreed). Sixty six percent (66%) of indicated that in-service of training is conducted for small holder farmers, 5% were undecided, 19% disagreed while 10% strongly disagreed. According to Caswell *et al*. (2001), exposure to information about new technologies as such significantly affects farmers' choices about it. Feder and Slade (1984) indicate how, provided a technology is profitable, increased information induces its adoption. In the cases where experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it. This negatively affects the adoption of technology among small holder farmers.

Table 4.11: Availability of Agricultural Extension Services on Adoption of Agricultural Technology

Variables	**Pearson Correlation Coefficient, r**
Small holder farmers are aware of yield-raising technologies, such as improved seeds	0.298^{**} (0.000) s
Small holder farmers are aware of fertility-restoring and conservation technologies	0.235***** (0.003) s
Extension officers are always available to give farmers updated information on technologies	0.196 (0.051) ns
In-service of training is conducted for small holder farmers	0.181 (0.072) ns
Constant/predictor variable: Availability of Agricultural Extension Services	
Dependent Variable: Adoption of Agricultural Technology	

n= 144; s-significant; ns-not significant; ** *Correlation is significant at the 0.01 level (2-tailed);* * *correlation is significant at the 0.05 level (2-tailed).Levels of significance, p-value for correlation coefficients are in parentheses***.**

The results on correlation analysis in Table 4.9 revealed that small holder farmers are aware of yield-raising technologies, such as improved seeds ($r = 0.298^{**}$, $p<0.01$) and that small holder farmers are aware of fertility-restoring and conservation technologies (r = 0.235***,** $p<0.05$) had positive and significant on the adoption of agricultural technology. It should be noted that these correlation values were below r = 0.5, an indication of a marginal weak association between availability of agricultural extension services and adoption of agricultural technology. Other variables like extension officers are always available to give farmers updated information on technologies (r = 0.196) and in-service of training is conducted for small holder farmers (r = 0.181) did not have significant ($p>0.05$) association on the adoption of agricultural technology. Findings from the interviews indicated that availability of agricultural extension services was only limited to parts of Kakamega North Sub-County that were accessible and many parts of the sub-county did not receive sufficient information on yield-raising technologies and fertility-restoring and conservation technologies.

4.7 Influence of Market Availability on Adoption of Agricultural Technology

This section looks at availability of markets for the small holder farmers' produce in the Kakamega North Sub-County of the Kakamega North Sub-County. This was the fourth objective of the study. The results of this objective are shown in Table 4.10. Results indicate that there is ready market for the products (37% of respondents strongly agreed, 33% agreed, 9% were undecided, 12% disagreed while 9% strongly disagreed). On the question asked whether poor roads and scarcity of water negatively affect crop production and marketability, respondents gave varied responses (41% of respondents strongly agreed, 13% agreed, 4% were undecided, 29% disagreed while 13% strongly disagreed).

Table 4.10: Influence of Market Availability on Adoption of Agricultural Technology

Variables	**SA %**	**A %**	**U %**	**D %**	**SD %**
There is ready market for the products	37.0	33.0	9.0	12.0	9.0
Poor roads and scarcity of water negatively affect crop production & marketability	41.0	13.0	4.0	29.0	13.0
Products are of low quality affecting their marketability	35.0	33.0	8.0	18.0	6.0
Marketability of products has been improved due to advancement in technologies	38.0	28.0	5.0	19.0	10.0

n = 144; Key: SA = strongly agree, A = agree, U = undecided, D = disagree and SD = strongly disagree

Mixed responses were also given on the question whether the products of low quality affect their marketability (35% of respondents strongly agreed, 33% agreed, 8% were undecided, 18% disagreed while 6% strongly agreed). Sixty six percent (66%) of respondents indicated that the marketability of products has been improved due to advancement in technologies, 5% were undecided, 19% disagreed while 10% strongly agreed. It was also observed that individual preferences around product attributes, including taste and cultivation practices, will affect how profitability is perceived by the household. According to Adesina and Akinwumi (1993), farmer perceptions of technology attributes, such as ease of preparation and cooking, have been linked directly to adoption outcomes. Technologies imported from other regions may have different flavors and textures than local substitutes and may not be adopted even if they increase yields and income.

Table 4.11: Influence of Market Availability on Adoption of Agricultural Technology

Variables	**Pearson Correlation Coefficient, r**
There is ready market for the products	0.295** (0.000) s
Poor roads and scarcity of water negatively affect crop production & marketability	0.247* (0.003) s
Products are of low quality affecting their marketability	0.188 (0.051) ns
Marketability of products has been improved due to advancement in technologies	0.192 (0.072) ns

Constant/predictor variable: Market Availability
Dependent Variable: Adoption of Agricultural Technology

n= 144; s-significant; ns-not significant; ** *Correlation is significant at the 0.01 level (2-tailed);* * *correlation is significant at the 0.05 level (2-tailed).Levels of significance, p-value for correlation coefficients are in parentheses*.

Further statistical analysis in Table 4.11 revealed that market availability has a positive and significant ($p<0.05$) on the adoption of agricultural technology in the Kakamega North Sub-County. It should be noted that these correlation values were below $r = 0.5$, an indication of a marginal weak association between the variables of market availability on adoption of agricultural technology.

4.8 Demographic Characteristics of Farmers and Adoption of Agricultural Technology

This was the fifth objective of the study. This section looks at the demographic characteristics of farmers and these affect the adoption of in the Kakamega North Sub-County of the Kakamega North Sub-County. The results of this objective are shown in Table 4.12.

Table 4.12: Demographic Characteristics of Farmers and Adoption of Agricultural Technology

Variables	SA %	A %	U %	D %	SD %
Farmers' educational level influences adoption of technology	45.0	25.0	10.0	9.0	11.0
Gender has insignificant influence on adoption of technology	13.0	17.0	5.0	28.0	37.0
Males and females adopt technology equally	19.0	6.0	7.0	36.0	34.0
Age is a primary latent characteristic in adoption decisions	39.0	29.0	3.0	21.0	10.0
Older farmers are more resistant to technology than young ones	43.0	34.0	8.0	12.0	3.0

n = 144; Key: SA = strongly agree, A = agree, U = undecided, D = disagree and SD = strongly disagree

Results indicate that farmers' educational level influences adoption of technology (45% of respondents strongly agreed, 25% agreed, 10% were undecided, 9% disagreed while 11% strongly disagreed). On the question asked whether gender has insignificant influence on adoption of technology, respondents gave varied responses (13% of respondents strongly agreed, 17% agreed, 5% were undecided, 28% disagreed while 37% strongly agreed). This meant that gender played a significant role on the adoption of technology. This finding has been refuted by Doss and Morris (2001) in their study on factors influencing improved maize technology adoption in Ghana, and Overfield and Fleming (2001) studying coffee production in Papua New Guinea show insignificant effects of gender on adoption. Varied responses were also given on the question asked whether males and females adopt technology equally (19% of respondents strongly agreed, 6% agreed, 7% were undecided, 36% disagreed while 34% strongly disagreed). Sixty six percent (66%) of respondents indicated that age is a primary latent characteristic in adoption decisions, 3% were undecided, 21% disagreed while 10% strongly disagreed. Moreover, the question asking whether older farmers are more resistant to technology than young ones received varied responses, although the majority of the respondents (77%) supported the statement, 8% were undecided, 12% disagreed while 3% strongly disagreed.

The study also carried out correlation between the demographic characteristics and the adoption of agriculture technology. The findings based on these factors are summarized inTable 4.13

Table 4.13: Demographic Characteristics of Farmers and Adoption of Agricultural Technology

Variables	Pearson Correlation Coefficient, r
Farmers' educational level influences adoption of technology	0.321** (<0.05) s
Gender has insignificant influence on adoption of technology	0.233* (<0.00) s
Males and females adopt technology equally	0.179 (>0.05) ns
Age is a primary latent characteristic in adoption decisions	0.193 (>0.05) s
Older farmers are more resistant to technology than young ones	0.023 (>0.05) s
Constant/predictor variable: Demographic Characteristics of Farmers	
Dependent Variable: Adoption of Agricultural Technology	

n= 144; s-significant; ns-not significant; ** *Correlation is significant at the 0.01 level (2-tailed);* * *correlation is significant at the 0.05 level (2-tailed).Levels of significance, p-value for correlation coefficients are in parentheses*.

The results on correlation analysis in Table 4.13 revealed that demographic characteristics of farmers had positive and significant on the adoption of technology but at varying degrees in Kakamega North Sub-County. Notably, the farmers' educational levels, gender and age had positive and significant influence on the adoption of technology while the variable on males and females adopting technology equally had positive but insignificant influence.

It should be noted that these correlation values were below r = 0.5, an indication of a marginal weak association between demographic characteristics of farmers and the adoption of technology in Kakamega North Sub-County. Previous studies have shown that education is thought to reduce the amount of complexity perceived in a technology thereby increasing a technology's adoption. According to Ehler and Bottrell (2000), one of the hindrances to widespread adoption of IPM as an alternative method to chemical control is that it requires greater ecological understanding of the production system.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of study findings, conclusions drawn, recommendations based on the conclusions and suggestions for further research.

5.2 Summary of the Findings

Results show that the majority of respondents were in the age brackets of 20-29 years 78(54.2%), 30-39 years 13(9%) and 40-49 years had 53(36.8%). There was a significant difference among respondents in the age distribution since expected uniform distribution across age groups was not achieved in each age bracket. Majority of the respondents were males 104(72.2%) while the rest were females 40(27.8%). The results illustrated that there was a significant ($p<0.05$) variation in the gender distribution among the respondents since the expected 50% was not attained because the number of males was more than that of females who participated in the study. Therefore results show that gender equity among the respondents who participated in this study was not achieved. Further results on the working experience of respondents illustrate that 91(63.2%) of the respondents have been working for less than 5 years, 13(9%) working for 5-10 years, 29(20.1%) for 10-15 years and those above 15 years were represented by 11(7.6%). This indicated that most respondents had acquired some experience, knowledge and skills to varying degrees to understand how the various factors affect the adoption of agricultural technology among smallholder farmers. Results show that 28.5% of respondents had diploma educational level, 56.3% had bachelor's degree education level and 15.2% of respondents had masters' degrees. There was a significant ($p<0.05$) difference in the levels of respondents' education, an indication of respondents' different understanding of how the various factors affect the adoption of agricultural technology among smallholder farmers.

On how capital and credit facilities influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County, Regression analysis revealed that capital and credit facilities had positive and significant association on the adoption of agricultural technology but at varying degrees, an indication that there was a moderate association between the capital and credit facilities and adoption of agricultural technology.

On how training influences the adoption of agricultural technology among small holder farmers in Kakamega North Sub-County, the correlation results show that training has a positive and significant influence on the adoption of technologies among smallholder farmers, though the degree of adoption of technologies is low signified by low r-values ($r<0.5$).

The results on correlation analysis in Table 4.9 revealed that small holder farmers are aware of yield-raising technologies, such as improved seeds ($r = 0.298^{**}$, $p<0.01$) and that small holder farmers are aware of fertility-restoring and conservation technologies ($r = 0.235$*****, $p<0.05$) positive and significant on the adoption of agricultural technology. It should be noted that these correlation values were below $r = 0.5$, an indication of a marginal weak positive association between availability of agricultural extension services and adoption of agricultural technology.

On how market availability influences the adoption of agricultural technology among small holder farmers Results revealed that market availability has a positive and significant ($p<0.05$) on the adoption of agricultural technology in the Kakamega North Sub-County. It should be noted that these correlation values were below $r = 0.5$, an indication of a marginal weak association between the variables of market availability on adoption of agricultural technology.

The results between demographic characteristics of farmers and the adoption of technology indicate that there was a positive and significant between these variables but at varying degrees in Kakamega North Sub-County. Notably, the farmers' educational levels, gender and age had positive and significant influence on the adoption of technology while the variable on males and females adopting technology equally had positive but insignificant influence.

5.3 Conclusions

The study had the following conclusions:

Capital and credit facilities had positive and significant association on the adoption of agricultural technology but at varying degrees. This implies that an increase in capital and credit facilities could result to higher rate of agricultural technology adoption.

Results indicated that training has a marginally positive and significant influence on the adoption of technologies among smallholder farmers. This means that the level of training of small holder farmers is low as far as technologies were concerned.

There was a marginal weak positive association between availability of agricultural extension services and adoption of agricultural technology. This was attributed to inefficient and poorly trained extension officers on technology adoption.

Results revealed that market availability has a positive and significant ($p<0.05$) on the adoption of agricultural technology. The association between these two variables was marginally weak an indication of marketability of farmers' products not being effective as a result of poor infrastructure.

The farmers' educational levels, gender and age had positive and significant influence on the adoption of technology while the variable on males and females adopting technology equally had positive but insignificant influence.

5.4 Recommendations

The following recommendations were made based on the findings and the conclusions of the study:

1. There is a need to increase farmers' capital and credit facilities and make these services accessible to the farmers. The Government and other stakeholders can provide tax free tools and equipment to the farmers.

2. There is need for farmers and extension officers to be trained on yield-raising technologies and fertility-restoring and conservation technologies and other technologies that can positively contribute to high productivity among farmers. This will increase awareness on the availability and usefulness of the technologies.

5.5 Suggestion for Further Research

Significant research gaps remain in this area of study which will need to be filled in order to increase the effectiveness of technology adoption in Kakamega North Sub-County. These areas are:

1. Research on other factors that affect adoption of technology in other sub-counties.
2. Influence of the moderating variables like resource adequacy, Government policies and community cooperation on the adoption of technology

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APPENDICES

APPENDIX 1: LETTER OF TRANSMITTAL FOR DATA COLLECTION

February, 2014.

Dear respondent:

I am a postgraduate student undertaking a Master of Arts in Project Planning and Management in the School of Continuing and Distance Education at the University of Nairobi. I am carrying out a study on **Factors Influencing the Adoption of Agricultural Technology among Smallholder Farmers in Kakamega North Sub-County, Kenya.** I am using the attached questionnaire and interview schedules to collect information for the study. It is my kind request that you fill the questionnaire, providing the relevant information to facilitate the study. Please use the space provided to fill in the information required as objectively and honestly as possible. The information provided will be treated with strict confidentiality for the purpose of this study only.

Thank you.

Yours faithfully,

Audrey Amagove Kinyangi
L50/82172/2012
0729-725-580

APPENDIX 2: QUESTIONNAIRE FOR KEY INFORMANTS

SECTION A: BACKGROUND INFORMATION

1. Please indicate your age bracket?

20-29 years	[ ]
30-39 years	[ ]
40-49 years	[ ]
Above 50 years	[ ]

2. Please indicate your gender

Male	[ ]
Female	[ ]

3. Please state the number of years you have been working in your organisation

Less than 5 years	[ ]
5-10 years	[ ]
11-16 years	[ ]
Above 16 years	[ ]

4. Please indicate your education level

Masters	[ ]
Bachelor’s degree	[ ]
Diploma	[ ]
Certificate	[ ]

Others (specify)………………………………………………………………

5. How do you rate your workload?

High [ ]   average [ ]   low [ ]   Manageable [ ]

SECTION B: FACTORS INFLUENCING ADOPTION OF AGRICULTURAL TECHNOLOGY

In this section please tick (√) the most appropriate response for each of the questions in the table below with the scores in the bracket. **Strongly agree (SA) = 5, Agree (A) = 4, undecided (U) = 3, Disagree (D) =2 and Strongly disagree (SD) = 1**

Q.		SA	A	U	D	SD
	To what extent do the following factors affect adoption of agricultural technology among small holder farmers?					
1.	Education level					
2.	Cost of technology					
3.	Availability of equipment and tools					
4.	Availability of cash					
5.	Availability of credit facilities like soft loans					
6.	Exposure to technologies					
7.	Training of farmers on agricultural technology					
8.	Farmers are trained on improved yield-raising technologies, such as improved seeds					
9.	Farmers are trained on how to use variety of tools and equipment					
10.	Extension workers undergo in-service training					
11.	There is information/creation of awareness to small holder farmers					
12.	Small holder farmers are aware of yield-raising technologies, such as improved seeds					
13.	Small holder farmers are aware of fertility-restoring and conservation technologies					
14.	Extension officers are always available to give farmers updated information on technologies					
15.	In-service of training is conducted for small holder farmers					
16.	Market availability for the products					
17.	There is ready market for the products					

18.	Poor roads and scarcity of water negatively affect crop production & marketability					
19.	Products are of low quality affecting their marketability					
9.	Marketability of products has been improved due to advancement in technologies					
10.	Age is a primary latent characteristic in adoption decisions					
11.	Older farmers are more resistant to technology than young ones					
12.	Risk and uncertainty that may result in low technology uptake					
13.	Farmers' educational level influences adoption of technology					
14.	Gender has insignificant influence on adoption of technology					
15.	Males and females adopt technology equally					

16. How do you rate of adoption of technology among small holder farmers?

High [ ] average [ ] low [ ]

17. If the responses in Q.16 are average/low, what do think are the possible causes for theaverage/low adoption rate?

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18. What do you think can be done to improve adoption of technology among small holder farmers in Kakamega North Sub-County?

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APPENDIX 3: INTERVIEW SCHEDULE FOR SMALL HOLDER FARMERS

Introduction: Good morning or afternoon sir/madam.I am carrying out a study on the **Factors Influencing the Adoption of Agricultural Technology among Smallholder Farmers in Kakamega North Sub-County, Kenya.** Thank you for having granted me permission to interview you. I would like to assure you that I will stick to all ethical codes of conduct with regard to conducting research as stated in my introduction letter.

The Interview Questions:

1. How do you rate of adoption of technology among small holder farmers?

2. What do think are the possible causes for the average/low adoption rate among small holder farmers?

3. What do you think are the major factors affecting the rate of adoption of technology among small holder farmers?

4. What do you think can be done to improve adoption of technology among small holder farmers in Kakamega North Sub-County?

Conclusion: Thank you for your time and I hope your responses to the questions will contribute a lot to my research work.

APPENDIX 4: MAP OF KAKAMEGA COUNTY SHOWING ADMINISTRATIVE DISTRICTS