FACTORS INFLUENCING ADOPTION OF GREENHOUSE FARMING TECHNOLOGY AMONG SMALL SCALE HORTICULTURE FARMERS IN GEM SUB-COUNTY, KENYA

BY

CHARLES OWINO DWASI

A Research Project Submitted In Partial Fulfillment of The Requirement For The Award of Master of Arts Degree In Project Planning And Management of The University of Nairobi

2017

DECLARATION

This research project proposal is my original work and has not been submitted to any other university for any award.

Sign……..…… Date……..…

Charles Owino Dwasi

L50/84816/2016

This research project proposal has been submitted for examination with our approval as University supervisors.

Sign…… Date…….

Prof. Charles M. Rambo

School of Open and Distance Learning

University of Nairobi, ODeL Campus.

Sign…… Date…….

Dr. Joyce A. Osogo

School of Open and Distance Learning

University of Nairobi, ODeL Campus.

DEDICATION

This research project is dedicated to my family for their sacrifices and moral support.

ACKNOWLEDGEMENT

I wish to acknowledge the invaluable guidance, encouragement and contributions of my supervisors Prof. Charles M. Rambo and Dr. Joyce A. Osogo for shaping my thoughts and ensuring that this report is well written, completed and presented within reasonable time for defense. I also wish to recognize the constant support of my family; your financial support and encouragement has seen me this far. Finally to all 2016 project planning and management class; I thank you for your support during the coursework, particularly during group discussion and presentations. Since it is not possible to mention everyone individually, kindly take this acknowledgement as an expression of my sincere gratitude.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABREVIATIONS

KAPP: Kenya Agricultural Productivity Project

NALEP: National Agriculture and Livestock Extension Program

ASDSP: Agriculture Sector Development Support Program

NAAIAP: National Accelerated Agriculture Inputs Access Program

KARI: Kenya Agricultural Research Institute

SRA: Strategy for Revitalizing Agriculture

NERICA: New Rice for Africa

R&D: Research and Development

SSA: Sub-Saharan Africa

ICRISAT: International Crops Research Institute for Semi-Arid Tropics

FGD: Focused Group Discussion

CIMMYT: International Maize and Wheat Improvement Centre

FAO: Food and Agriculture Organization

HYV: High Yielding Variety

MDG: Millennium Development Goal

SPSS: Statistical Package for Social Sciences

GDP: Gross Domestic Produce

IPM: Integrated Pest Management

FFS: Farmer Field School

SMEs: Small and Medium Enterprises

FFS: Farmer Field School

ABSTRACT

Food security continues to be a major concern all over the world while the role of technology in agricultural production has been growing in importance with time. Greenhouses are quickly gaining popularity in Kenya as progressive farmers get more acquainted with modern technologies available in the sector. There use is mostly informed by unfriendly environmental conditions which are not favorable for open field crop production. This study aimed at establishing factors influencing adoption of greenhouse technology among small scale farmers in Gem Sub-County, Kenya. This is in line with vision 2030 which identifies agriculture as a key sector through which annual economic growth rate of 10 percent can be achieved. In this regard the following objectives guided the study:- To assess how access to financial capital influences adoption of greenhouse technology among small scale horticulture farmers; To establish the extent to which technical skills of greenhouse influences the adoption of greenhouse technology among small scale horticulture farmers; To establish the extent to which availability of market influences the adoption of greenhouse technology and To determine the extent to which technology characteristics influences the adoption of greenhouse technology among small scale farmers in Gem sub-county. Innovation diffusion theory as advanced by Rodgers (1995) was adopted in this study. This research adopted a descriptive survey design. Systematic random sampling and purposive sampling was used to choose a sample from open field and greenhouse horticulture farmers respectively to participate in the study. The target population was 37,203 small scale horticulture farmers in Gem Sub-County. The study employed Yamane's (1967) formula to arrive at a sample of 395 respondents. The researcher carried out a pilot study in Kisumu west Sub-County on a sample comprising 15 respondents. The study adopted a semi-structured questionnaire to collect data from the respondents. The instruments were validated using content validity through discussion with supervisors and other professional experts. Mean and standard deviation were used to analyze descriptive statistics with the aid of statistical package for social sciences version 20 and the findings presented using frequency distribution tables The findings of this study is expected to provide insight to various stakeholders in Gem sub-county on factors influencing adoption of greenhouse farming among small scale farmers. The findings indicated that access to financial capital; technical skills; availability of market and technology characteristics influenced adoption of greenhouse farming technology among small scale farmers. The study revealed that 87% of respondents reported lack of access to credit as a major factor influencing adoption of greenhouse technology. The study also showed that market stability was significant with 80% of the respondents citing the same. User perception and technical skills were also cited as factors influencing adoption of greenhouse technology with 71% and 66% of the respondents respectively. The study made the following recommendations: The study recommended the need to increase smallholder farmer's capital and credit facilities and make these services accessible to the farmers and to further improve institutional and infrastructure development to ensure broad-based, low cost market access, and well-functioning input and output marketing

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study.

The Green Revolution that boosted the yields of cereals in Europe and Asia as indicated in the empirical literature (David and Otsuka, 1994; DeJanvry and Sadoulet, 2002; Moser and Barrett, 2003) is an indication that increased agricultural technology uptake is key to modern day agricultural transformation and poverty reduction. Technological change in the form of uptake of improved agricultural production systems has been reported to have significant improvement on agricultural productivity in the developing world (Nin *et al*, 2003). Enhancing technical change through the generation of agricultural technologies by research and their transfer to end users plays a key role in enhancing agricultural productivity in developing countries (Mapila, 2011). At the global level, the adoption of improved agricultural technologies is now considered critical to the attainment of the Millennium Development Goal (MDG) 1 of reducing extreme poverty and hunger.

The global demand and consumption of food is increasing and in the near future the human population is projected to rise and increase the demand further (Jelle, 2003). Much of this increase is being experienced in developing countries. The Nations should be prepared by working on interventions to cope with food crises and permanently deal with their causes (FAO, 2003). Africa's population is projected to double to two billion people by 2050, and food production will need to increase in order to meet the needs of high population (Lamboll, Nelson & Nathaniels, 2011). This calls for increased agricultural productivity which can be achieved by embracing technologies such as greenhouse farming which is associated with; high yields, efficient water utilization, high fruit quality, prolonged production and shortened maturity period (EAFPJ, 2012).

In India, Kholi and Singh (1997) conducted a comparative study on uptake of high yielding varieties (HYVs) among states in India and inferred that fast adoption of the HYVs in Punjab was because of cheap and simple access to the innovation itself and the integral sources of information. As confirmed by McGuirk and Mundlak (1991) in their

examination in India utilizing decision of method structure, HYVs require large amounts of compost info and water system to understand the yield potential. Hence, correlative sources of info must be accessible and reasonable to upgrade adoption of HYVs.

In another examination in India, Besley and Case (1993) utilized a model of learning in a circumstance where the benefit of innovation selection was uncertain and beyond the farmer's control in India. They found that likelihood of embracing agricultural technology increases as farmers understand the profitability of the new innovation. Utilizing an objective information model of new innovation which expect that the best utilization of an info is obscure and irregular, Foster and Rosenzweig (1995), and Conley and Udry (2002) discovered comparable outcomes. Foster and Rosenzweig (1995) contemplated reception of HYVs in India while Conley and Udry (2002) considered utilization of compost in pineapple development in Ghana. . These authors presumed that underlying reception might be low because of blemished data on management and gainfulness of the new innovation yet as this progresses toward becoming clearer from the encounters of their neighbors and their own encounters, adoption is scaled up. This is bolstered by Bandiera and Rasul (2006) who analyzed the connection between informal communities and innovation appropriation in Northern Mozambique and noticed that a rancher who talked about agriculture with others had a higher inclination to receive new technologies.

In USA, Griliches (1957) on adoption of new agricultural advancements. Griliches inspected heterogeneity of local conditions and how it influenced adoption of cross breed corn in the mid-western United States. He noticed the part of financial factors, for example, expected profits in affecting the variety in farm technology innovation spread rates. He additionally noticed that speed of adoption across geographical locations relied upon the providers of the innovation and appropriateness of the seed to local conditions. It is undoubtedly the work by Griliches that monetary writing on agrarian innovation adoption developed. A portion of the variables that conceivably clarify the rate of adoption and the long-run equilibrium level of adoption of new agricultural technology as distinguished in the monetary writing include: credit constraints, risk aversion, the farmer's landholding size, land tenure system, human capital endowment, quality and quantity of farm

equipment, and supply of complementary inputs (Feder et al. 1985). Among the studies that have adopted this approach are Makokha et al. (2001), Ouma et al. (2002), and Wekesa et al. (2003). Makokha et al. (2001) examined determinant of adoption of fertilizer and manure in Kiambu District, focusing on soil quality as reported by the farmers. They found high cost of labour and other inputs, unavailability of demanded packages and untimely delivery as the main constraints to fertilizer adoption. Ouma et al. (2002) focused on adoption of fertilizer and hybrid seed in Embu District and found that agro-climate, manure use, cost of hired labour, gender of the farmer and access to extension services were important determinants of adoption. Wekesa et al. (2003) examined adoption of improved maize varieties and fertilizer in the coastal lowlands of Kenya and found that unsuitable climatic conditions, high cost and unavailability of seed, perceived soil fertility and low financial endowments were responsible for the low adoption. The above findings are consistent with those of the International Maize and Wheat Improvement Center (CIMMYT) studies as summarized by Doss (2007).

In Japan, Chi and Yamada (2002) carried out a study 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 had 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. Bandiera and Rasul (2002) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who reported discussing agriculture with others. Besley and Case (1993) use a model of learning where the profitability of adoption is uncertain and exogenous. Looking at a village in India, they found that once farmers discover the true profitability of adopting the new technology, they are more likely to adopt. Alternatively, Foster and Rosenzweig (1995) and Conley and Udry (2002) use a target-input model of new technology which assumes that the best use of inputs is what is unknown and stochastic. Applying this model to high yielding varieties (HYV) adoption in India, Foster and Rosenzweig (1995) found that

initially farmers may not adopt a new technology because of imperfect knowledge about management of the new technology; however, adoption eventually occurs due to own experience and neighbors' experience. Similarly, Conley and Udry (2002), looking at pineapple cultivation in Ghana, analyze whether an individual farmer's fertilizer use responds to changes in information about the fertilizer productivity of his neighbor. They found that a farmer increases (decreases) his fertilizer use when a neighbor experienced higher than expected profits using more (less) fertilizer than he did, indicating the importance of social learning.

In Kenya, a study by Olwande, Sikei and Mary using panel data to examine determinants of fertilizer adoption and intensity of use. Using a double-hurdle model, they found that age and education of the farmer, access to credit, presence of a cash crop, distance to fertilizer market and agro-ecological potential influence the probability of fertilizer adoption. Gender of the farmer, dependency ratio, credit access, presence of cash crop, distance to extension services and agro-ecological potential were found to influence intensity of fertilizer use. A double-hurdle model is useful in capturing intensity of adoption but it ignores the fact that adoption of fertilizer could also be influenced by related practices such as adoption of improved maize seed.

In another study 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 their 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 that 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

With the support of development partners, the government of Kenya has introduced and implemented several efficiency and productivity-enhancing technologies, program and projects at household level. Among the projects and programs are the Kenya Agricultural Productivity Project (KAPP), the National Agriculture and Livestock Extension Program (NALEP), the Agriculture Sector Development Support Program (ASDPS) and the National Accelerated Agricultural Inputs Access Program (NAAIAP). Improved technologies for soil and water conservation, improved storage facilities, labor-saving and improved seeds have also been developed and disseminated, particularly by the Kenya Agricultural Research Institute (KARI). Despite the efforts by the government and development partners, levels of technology adoption remain low (Republic of Kenya 2007; Ogada et al. 2010).

1.2 Statement of the Problem

Enhancing the adoption of appropriate agricultural technologies and practices is one of the imperative themes identified in the Strategy for Revitalizing Agriculture (SRA) for improving agricultural sector productivity and competitiveness in Kenya. The government proposes to restructure the agricultural research systems to enable it to address responsive and efficient technology development and transfer by: Increasing budgetary allocation for agriculture research to 2 percent of the GDP by 2010; accelerating commercialization of research products including contracts, and royalties for sustainability, and involving stakeholders in research priority setting. The strategy also proposes to restructure the extension service to respond to user demands through: partially privatizing the extension service to compliment public services; encouraging stakeholder participation in service provision; facilitating and promoting capacity building of extension service providers, and

developing performance standards and monitoring evaluation frameworks for extension services (Republic of Kenya 2004).

Kenya Vision 2030 identifies agriculture as a key sector through which annual economic growth rates of 10 percent can be achieved. Under the Vision, smallholder agriculture will be transformed from subsistence activities, marked by low productivity and value addition, to 'an innovative, commercially-oriented, internationally competitive and modern agricultural sector'. The Ministry of Agriculture in Kenya released a policy statement on promoting sustainable and competitive agriculture through formulation of agricultural policies aimed at promoting agricultural technology, provision of extension and regulatory services for agricultural development in order to attain food security for all Kenyans. (Ministry of Agriculture, 2008). One of the main focus of the agriculture sector is to promote technology adoption among among smallholder farmers. However, despite the efforts by the government and development partners, levels of technology adoption remain low (Republic of Kenya 2007; Ogada et al. 2010).

Despite decades of investment in new agricultural technology, hunger and poverty continue to plague large areas of the developing world. This is particularly true in Sub-Saharan Africa where the impact of technologies has been less apparent. For agricultural technology to effectively contribute in raising productivity and poverty reduction, a set of interventions are also needed. These include secure output markets, effective supply systems (including credit), secure and equitable access to land and supporting infrastructure such as roads, telecommunication and irrigation (Dorward et al. 2004). While there is scanty literature review on factors influencing greenhouse farming technology adoption in Kenya, no study has been conducted in Gem sub-county on factors influencing adoption of greenhouse technology.

1.3 Purpose of the Study

The purpose of this study was to determine the factors influencing the adoption of greenhouse technology among small scale horticulture farmers of Gem sub county, Siaya County, Kenya.

1.4 Objectives of the Study

This study was guided by the following objectives;

1. To assess how access to financial capital influences adoption of greenhouse technology among small scale horticulture farmers in Gem Sub-County.
2. To establish the extent to which technical skills influences the adoption of greenhouse technology among small scale horticulture farmers in Gem Sub-County.
3. To establish the extent to which availability of market influences the adoption of greenhouse technology in Gem Sub-county
4. To determine the extent to which technology characteristics influence the adoption of greenhouse technology in Gem Sub-County.

1.5 Research Questions

The study sought to answer the following research questions:

1. How does access to financial capital influence adoption of greenhouse technology in Gem Sub-County?
2. To what extent does technical skills of greenhouse influence the adoption of greenhouse technology in Gem Sub-County?
3. How does availability of market influence the adoption of greenhouse technology in Gem Sub-County?
4. To what extent does technology characteristics influence the adoption of greenhouse technology in Gem Sub-County?

1.6 Significance of the Study

It is hoped that the findings of this study will be useful to Siaya County Government and development partners in Gem Sub-County as documented data will enable them to establish the factors that influence the adoption of greenhouse farming technology and thus

design new strategies to improve on the adoption rates. It is anticipated that the study will be useful to extension service providers as findings will enable them come up with new extension models to improve their efficiency and effectiveness in technical information delivery that will stir up the uptake and adoption rates of the technology. The findings of this study will also help the small scale farmers in Gem Sub-County understand the underlying reasons contributing to the low adoption of greenhouse technology. It is therefore hoped that findings of this study will add impetus to the body of knowledge by building a profound foundation upon which other related studies can be anchored

1.7 Basic Assumptions of the Study

The study was conducted based on the assumptions that respondents participated freely in the study and answered questions truthfully and correctly and the sample size selected for the study was a true reflection of the entire targeted population. Similarly, research tools considered for this study were able to measure appropriately and adequately the variables under investigation. Lastly, access to financial capital, technical skills of greenhouse, market availability and technology characteristics affect the adoption of greenhouse technology in Gem Sub-County, Siaya County, Kenya.

1.8 Limitations of the Study

The researcher encountered the following shortcomings: the study targeted 395 small scale horticulture farmers, reaching all these farmers was not easy. To overcome this limitation, the researcher employed research assistants. The scope of the study was limited to factors affecting the adoption of greenhouse farming technology in Gem sub-county; this will limit generalizing the findings of the study to other areas of the country except Gem sub-county.

1.9 Delimitations of the Study

The study will be delimited to small scale greenhouse horticulture farmers in Gem sub-county since they are perceived to have the right information on greenhouse farming technology. This study will also be delimited to factors influencing adoption of greenhouse technology specifically among small scale farmers in Gem sub-county.

1.10 Definition of Significant Terms Used In the Study

Greenhouse Farming: The practice of cultivating fruits and vegetables in a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown.

Technology Adoption: This is a process that begins with awareness of the technology and a series of decision and steps a farmer makes that leads to effective usage.

Small Scale Farmer: These are farmers who produce crops and livestock on a small piece of land; it plays a dual role of being a source of household food security as well as income from sale of surplus

Horticulture: A branch of agriculture that deals with cultivation of vegetables and fruits.

Financial Capital This is the money, credit, and other forms of funding that a farmer uses to invest in their greenhouse farming businesses.

Technical Skills These are the greenhouse operational skills required by the farmer to be able to manage the Greenhouse

Output Market The market in which greenhouse horticulture products are sold.

Technology Characteristics This are special or specific features that helps the farmer to distinguish property and make a decision to adopt or not

1.11 Organization of the Study

The study will be organized into five chapters; chapter one highlighted the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, basic assumptions of the study, limitations of the study, delimitations of the study and the definition of key terms as used in the study. Chapter two focused on the review of literature presented under access to financial capital and adoption of greenhouse technology, technical skills of greenhouse and adoption of greenhouse technology, availability of market and adoption of greenhouse technology and technology characteristics and adoption of greenhouse technology. The chapter also highlighted on the theoretical framework, conceptual framework and summary of literature reviewed. Chapter three covered research methodology, which focused on the research design, target population, sample size and sampling procedures, data collection instruments, data collection procedures, data analysis techniques and ethical issues in research.

Chapter four covered data analysis, presentation, discussion and interpretation of findings based on the four variables under study namely access to financial capital, technical skills, availability of market and technology characteristics. The chapter provides information on the response rate, demographic characteristics of respondents which included age, gender, level of education. The chapter provided information on the response rate, demographic characteristics of respondents that included age, gender and level of education. Concerning access to financial capital, information on cost of greenhouse, financial support and income levels was presented. Regarding technical skills, information on proximity to urban centers, market stability and type of market was captured. On technology characteristics, data on user perception, cost of technology and perceived risk of technology was given. Chapter five covered summary of key findings, conclusion and recommendations. This chapter also provided recommendation for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed literature related to factors influencing adoption of greenhouse technology among small scale farmers. The literature was reviewed per theme and sub-theme and covered the global, regional and local perspectives. This include: access to financial capital and adoption of greenhouse technology, technical skills and adoption of greenhouse technology, availability of market and adoption of greenhouse technology and technology characteristics and adoption of greenhouse technology. The theory related to technology adoption was discussed and a conceptual framework that depicts the relationship between variables was developed.

2.2 The Concept of Greenhouse Technology

Greenhouse crop production is now a growing reality throughout the world. The degree of sophistication and technology depends on local climatic conditions and the socio-economic environment. Adopters of improved technologies increase their productions, leading to constant socio-economic development. Adoption of improved agricultural technologies has been associated with: higher earnings and lower poverty; improved nutritional status; lower staple food prices; increased employment opportunities as well as earnings for landless laborers (Kasirye, 2010). Adoption of improved technologies was a major factor in the success of the green revolution experienced by Asian countries (Ravallion and Chen, 2004; Kasirye, 2010).On the other hand, non-adopters can hardly maintain their marginal livelihood with socio-economic stagnation leading to deprivation (Jain et al., 2009).

There is a large gap between what the smallholder farmer gets and what is achievable with the accessible technology in sub-Saharan Africa (Muhoho, 1989). The utilization of agricultural advancements influences the rate of increment in agrarian yield. It additionally decides how the expansion in horticultural yield impacts on destitution levels and

ecological corruption (Meinzen-Dick et al., 2002). In this way the focal point of late research has been to discover better farming practices. The focal point of research has likewise been on enhancements of land, soil and water administration hones (Meinzen-Dick et al., 2002). Be that as it may, the main path for smallholder ranchers to profit by these exploration station advancements is whether they see them to be fitting and continue to execute them on their farms (Meinzen-Dick et al., 2002). Expanded innovation advancement and reception can raise horticultural yield, thus enhance family unit sustenance. Improved food intake can likewise enhance the working of the human body and the performance of a healthy, typical life which will build work yield.

The adoption of improved agricultural technologies is said to be a vital pathway out of poverty for many farmers in developing countries (Bandiera and Rasul 2006; Mendola 2007). New agricultural technology that enhances sustainable production of food is therefore critical for sustainable food security and economic development. This has made the dynamics of technical change in farming to be an area of intense research since the early part of twentieth century (Loevinsohn etal, 2013). These technologies are particularly relevant to smallholder farmers in developing countries since they are compelled from various perspectives, which makes them a priority for advancement endeavors. These farmers for example, live and cultivate in territories where precipitation is low and inconsistent, and soils have a tendency to be fruitless. Furthermore, infrastructure and institutions, for example, water system, input and product markets, and credit and in addition farmer extension services have a tendency to be inadequately created (Muzari et al., 2012). However new agricultural technologies are often adopted slowly and several aspects of adoption remain poorly understood despite being seen as an important route out of poverty in most of the developing countries (Bandiera and Rasul, 2010; Simtowe, 2011).

At the global level, the adoption of improved agricultural technology is now considered critical to the attainment of the Millennium Development Goal (MDG) 1 of reducing extreme poverty and hunger. Although substantial public resources have been devoted to the development and provision of modern crop varieties in Sub-Saharan Africa (SSA) in

the past 30 years, overall adoption rates for improved technologies have lagged behind other regions (World Development Report, 2008).

2.3 The Concept of Horticulture Farming

The horticulture industry is the fastest growing agricultural sub-sector in the country, and is ranked third in terms of foreign exchange earnings from exports after tourism and tea (HCDA, 2009). In 2011 the horticultural industry earned the country Kenya shillings 91.2 billion from exports and an estimated Kenya shillings 113.8billion from the domestic market (Republic of Kenya, 2012). Horticulture contributes 36 percent of agricultural GDP and continues to grow at between 15 and 20 percent per year. The industry employs over six million Kenyans both directly and indirectly. Of the total horticultural production, about 95 percent is consumed locally while the remaining 5 percent is exported, yet in terms of incomes, the export segment earns the country large amounts of foreign exchange (Republic of Kenya, 2012). The Government has therefore identified horticulture as a major sub-sector in realizing the country's "Vision 2030" which envisages Kenya as middle income earner economy and semi-industrialized country by the year 2030. Recognizing the subsector as one of the most important ones in the achievement of the vision 2030, the government has put in place a national horticultural policy to propel the industry to growth and sustainability, with an objective to sustain the industry's growth and development to ensure among other objectives, food and nutrition security. The subsector is thus expected to contribute to the Millennium Development Goal number one that is aimed at halving the proportion of people who suffer from hunger by the year 2015, towards eradicating extreme poverty and hunger.

Kenya has been the second most successful sub-Saharan Africa exporter of horticultural products next to South Africa. The country is one of the world's leading exporters of fresh green beans (French and runner beans, snow peas and sugar snaps) as well as a minor exporter of tropical fruits (e.g. avocado, papaya and passion fruit). Other vegetables exported include squash, peas, chilli and sweet corn. The European Union (EU) is the dominant market for Kenyan exports after Morocco, Kenya is the biggest fresh vegetable supplier to the European Union. Other markets for Kenyan exports include Saudi Arabia

and South Africa (Legge etal.2006). Export of fresh fruits and vegetables from Kenya, targets almost exclusively the European market, thus stricter regulations, like European Retail Produce Working Group Good Agricultural Practices (EurepGAP), present a challenge for the Kenyan horticulture sector (Asfaw et al.2007). These exports have been associated with significant smallholder involvement in production. In the 1990s, researchers estimated that three quarters of fresh fruit and vegetable exports production came from small-holder growers (SHGs). However, smallholder participation has declined in recent years due to the high cost of managing smallholder out growers and the need to have a critical size and number (Legge etal. 2006). Most of the decline has occurred in Kenya, despite the large amount of donor support. This indicates the harsh reality and high risks of supplying fresh produce to this highly demanding sector. The small holder groups decline in number is mostly as a result of the increased costs and managerial burden associated with meeting private sector food safety standards and the decrease in external funds to maintain smallholder participation. Nevertheless, McCulloch and Ota (2002) report that smallholders participating in export horticulture, whether as producers or the workforce employed in the sector are better off than non-participating ones, with average annual household incomes of the former being high.

2.4 Access to Financial Capital and Adoption of Greenhouse Technology

The majority of rural farmers in sub-Saharan Africa are not able to purchase modern inputs because they lack equity capital and have limited access to credit (Langyintuo, 2010). In many of these economies, markets for credit and insurance are either not available or dysfunctional (Gruhn and Rashid, 2001). Available credit institutions mainly supply commercial loan products relative to risky agricultural loans (Gordon, 2000). Credit institutions set high collateral requirements and charge high interest rates, inhibiting farmers' access to credit (Gruhn and Rashid, 2001). Diversification into nonfarm income activities is an important strategy used by credit-constrained households to obtain investment capital (De Janvry and Sadoulet, 2001; Barrett et al., 2001; Reardon et al., 2007; Quinn, 2009). The decision to adopt is usually an investment decision. And as Caswell, (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).

On analyzing a study by Benjamin (2015) on Factors influencing smallholder farmers' access to agricultural microcredit in Northern Ghana using household survey data collected for the 2013/2014 farming season. The study approached the access to microcredit from two angles pertaining to the factors influencing access to loan and when accessed, the determinants of loan size. Heckman selection model was chosen as the analytical tool for addressing the possible presence of sample selectivity bias in the loan size regression. A multi-stage stratified random sampling technique was used to select 300 smallholder rice farmers from three irrigation schemes in Northern Ghana who were interviewed using a semi-structured questionnaire. The study revealed that the following factors influence access to agricultural microcredit in Northern Ghana: gender, household income, farm capital, improved technology adoption, contact with extension, the location of the farm, and awareness of lending institutions in the area. Gender, household size, farm capital, cattle ownership and improved technology adoption were the significant factors determining loan size. The study recommended the improvement of extension service delivery to smallholder farmers to enable them to access microcredit facilities for agricultural production.

In a study conducted by Moser and Barrett (2006) which analyzed 'farmers' decisions to adopt, expand, and dis-adopt high yielding rice varieties in Madagascar'. They fited a dynamic Tobit model of technology adoption under incomplete financial and lack of markets, and found that seasonal liquidity constraints discouraged adoption by poorer farmers. Similar to their study was a study by Coppenstedt et al. (2003) which used double hurdle model to 'examine the role of credit and subsidies on farmers' decision to use fertilizer in Ethiopia'. They also found that credit was the most important constraint to adoption of fertilizers. It has been noted that subsistence farmers want to use advanced farm technologies but do not have financial resources to purchase them (Duflo et al., 2008). They have limited access to credit because it is either not available or they do not have

collateral to get credit for farm investment (Hertz, 2009). Moreover, typical subsistence farmers are usually not able to save their farm earnings to purchase inputs later because they face several other needs that compete for the limited financial resources.

Similarly, an examination by Franklin (2010) on the 'impact of access to credit on the adoption of hybrid maize in Malawi' using a switching regression demonstrate. Results demonstrated that entrance to credit had a positive and critical impact on the likelihood of selection, while its impact on the degree of appropriation was not noteworthy. The suggestion from this finding was that entrance to credit improved the probability that a family would conceivably embrace half and half maize however restrictive on reception, access to credit does not prompt elevated amounts of selection. One clarification to the inconsequential impact of credit on the degree of appropriation in the full example was that the credit gave was not sufficiently high to essentially enhance the force of reception. His discoveries were reliable with the finding by Diagne and Zeller (2001) that as far as possible allowed by formal moneylenders in Malawi were moderately little in connection to the measure of credit requested. Zeller and Diagne (2001) had suggest a steady increment in credit sizes to rehash borrowers. Their other clarification was that not all credit was utilized for the generation of cross breed maize which was additionally affirmed by Diagne and Zeller (2001). All things considered, the finding that credit fundamentally improves the probability of selection is in accordance with an earlier desires and in simultaneousness with discoveries from various investigations that have demonstrated that the absence of access to credit altogether represses the reception of high yielding assortments notwithstanding when settled monetary expenses are not huge (Feder et al., 1985).

In an experiment conducted in Kenya, Duflo et al. (2011) find that farmers could only use farm revenue to purchase fertilizers immediately after harvesting. Their findings show that the proportion of farmers using fertilizer increased by at least 33% when farmers were offered the option to buy fertilizer immediately after the harvest. In the presence of imperfect credit markets, rural nonfarm income opportunities are expected to substitute for borrowed capital (Reardon, 1997; Ellis and Freeman, 2004), and can increase the collateral base of households (Reardon et al., 1994; and Barrett et al., 2001). This translates into

increased availability of resources to farmers for financing the purchase of improved technologies.

A study by Holden, (2004) using dynamic programming techniques to analyze the impact of improved access to non-farm income on household welfare, agricultural production, and conservation investments in the Ethiopian highlands. His results show that access to nonfarm income opportunities increased household income but reduced farmer incentives to invest in conservation, leading to rapid land degradation. Marenya and Barrett (2007) estimate a multivariate Probit model to quantify the determinants of adoption of natural resource management practices in Western Kenya, and found a positive and significant effect of non-farm income on use of inorganic fertilizers. Clay et al. (1998) fitted a random effects model to analyze the determinants of household intensification, emphasizing the effect of non-farm income on farmers' investment in land conservation and soil fertility in Rwanda. Their results indicated that non-farm income significantly increased investment in land conservation but had no effect on the use of chemical fertilizers. Chikwama (2010) used panel data to analyze the effect of rural non-farm employment among smallholder farmers in Zimbabwe. His findings showed no evidence of contribution of income from rural wage opportunities towards raising households' farm investment, which he attributed to low savings from rural wage employment. Savadogo et al. (1994; 1998) studied the relationship between animal traction use, productivity, and non-farm income in Burkina Faso. They found non-farm income to be an important indirect determinant of farm productivity, and ability to intensify production, through its influence on farmer adoption of animal traction. It is undisputable that small-scale farmers have always had a problem of access to credit. To improve the access improvement need to be made in the provision of financial services. Kgowedi et al., (2002) point out that in order to improve.

2.5 Technical Skills and Adoption of Greenhouse Technology

Literature on agricultural innovation, starting with Rogers (1995), asserts that awareness and knowledge of a new technology is the first step in the adoption process. The agricultural innovation literature suggests that knowledge only translates into adoption if a set of enabling factors and conditions exist, including farmers' positive perception of the

technology's benefits (Adesina and Zinnah 1993), access to complementary inputs (e.g. seed, fertilizer) (David, Mukandala and Mafuru 2002), tenurial arrangements and labor availability (Feder, Just and Zilberman 1985). Extension services primarily involve delivering the technical know-how, instructions, and hands-on training springing from research. Extension services in fact are identified as a key mode of technology transfer (Birkhaeuser et al., 1991; Dalton, 1980; Tripp et al., 2005). The technologies discovered at research level have to be disseminated to the prospective users for effective adoption (Cole, 1999; Shah etal., 2014). The dissemination role is played mainly by the extension services in the agricultural sector. In Kenya, the extension service is provided free of charge mainly by the public institutions, to promote novel technologies generated at research centers to improve the productive efficiency of farms.

In the context of technology adoption, behavior of farmers in response to extension contact, Hussain et al. (1994) were the first to explore the direct relationship between the practice and its impact on the technology adoption behavior of farmers. They examined the impact of the Training and Visit (T&V) system on the adoption of improved wheat technology, and stated that T&V had improved the farmers' knowledge and adoption of the technology. Moreover, Sheikh et al. (2003) have highlighted that the number of extension visits has a significant influence on the adoption of 'no-tillage' technologies by farmers in Pakistan's Punjab.

A study by Okunlola et al. (2011) on adoption of new technologies by fish farmers and Ajewole (2010) on adoption of organic fertilizers found that the level of education had a positive and significant influence on adoption of the technology. This is because higher education influences respondents' attitudes and thoughts making them more open, rational and able to analyze the benefits of the new technology (Waller et al., 1998). This eases the introduction of a new innovation which ultimately affects the adoption process (Adebiyi & Okunlola, 2010). Other studies that have reported a positive relationship between education and adoption as cited by Uematsu and Mishra (2010) include; Goodwin and Schroeder (1994) on forward pricing methods, Huffman and Mercier (1991); Putler and Zilberman (1988) on adoption of microcomputers in agriculture, Mishra and Park (2005); Mishra et

al. (2009) on use of internet on use of internet, Rahm and Huffman (1984) on reduced tillage, Robertset al. (2004) on precision farming and Traore, et al. (1998) on on-farm adoption of conservation tillage.

In addition, there are a few studies in extant literature that explore the impact of extension service on technology adoption; however, these studies analyze the implications indirectly. For example, using cost and benefit estimations, Feder and Slade (1986) have explored the effect of the Training and Visit (T&V) extension system on farmers' knowledge in the Hariyana state of India, and have found that the T&V system had led to rapid diffusion of knowledge in the area, leading to productivity improvement in the wheat-paddy cropping system. A similar study by Tripp et al. (2005) has examined the effect of Farmer Field School (FFS), a form of extension service, which has been introduced to Sri Lankan rice farmers to disseminate principles of Integrated Pest Management (IPM). The implications have been that, although the studies on FFS have influenced the reduction of insecticide use, they did not have the capacity to derive explicit conclusions of the effect of FFS. 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).

More recently, an influential body of literature on technology adoption has focused on the effect of social learning on adoption decisions. The basic motivation behind this literature is the idea that a farmer in a village observes the behavior of neighboring farmers, including their experimentation with new technology. Once a year's harvest is realized, the farmer then updates his priors concerning the technology which may increase his probability of adopting the new technology in the subsequent year.

A study by Bandiera and Rasul (2002) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who reported discussing agriculture with others. Besley and Case (1993) use a model of learning where the profitability of adoption is uncertain and exogenous. Looking at a village in India, they found that once farmers discover the true profitability of adopting the new technology, they are more likely to adopt. Alternatively, Foster and Rosenzweig (1995) and Conley and Udry (2002) use a target-input model of new technology which assumes that the best use of inputs is what is unknown and stochastic. Applying this model to high yielding varieties (HYV) adoption in India, Foster and Rosenzweig (1995) found that initially farmers may not adopt a new technology because of imperfect knowledge about management of the new technology; however, adoption eventually occurs due to own experience and neighbors' experience. Similarly, Conley and Udry (2002), looking at pineapple cultivation in Ghana, analyze whether an individual farmer's fertilizer use responds to changes in information about the fertilizer productivity of his neighbor. They found that a farmer increases (decreases) his fertilizer use when a neighbor experienced higher than expected profits using more (less) fertilizer than he did, indicating the importance of social learning. Regression results from a study of cowpea IPM in Uganda showed IPM knowledge was the most important variable in explaining the adoption of five IPM strategies (Erbaugh et al., 2007). Godtland and colleagues (2003) report that improved knowledge about IPM practices significantly impacted potato productivity. These results suggest that technical knowledge among FFS graduates is not only valuable as an outcome impact indicator, but could also serve as a reasonably reliable predictor of the adoption of management practices, particularly for crops and technologies where there is a relatively long time lag between adoption and impact.

A study by Bandiera and Rasul (2002) looked at social networks and technology adoption in Northern Mozambique and found that the probability of adoption is higher amongst farmers who reported discussing agriculture with others. Besley and Case (1993) use a model of learning where the profitability of adoption is uncertain and exogenous. Looking at a village in India, they found that once farmers discover the true profitability of adopting the new technology, they are more likely to adopt. Alternatively, Foster and Rosenzweig

(1995) and Conley and Udry (2002) use a target-input model of new technology which assumes that the best use of inputs is what is unknown and stochastic. Applying this model to high yielding varieties (HYV) adoption in India, Foster and Rosenzweig (1995) found that initially farmers may not adopt a new technology because of imperfect knowledge about management of the new technology; however, adoption eventually occurs due to own experience and neighbors' experience. Similarly, Conley and Udry (2002), looking at pineapple cultivation in Ghana, analyze whether an individual farmer's fertilizer use responds to changes in information about the fertilizer productivity of his neighbor. They found that a farmer increases (decreases) his fertilizer use when a neighbor experienced higher than expected profits using more (less) fertilizer than he did, indicating the importance of social learning. Regression results from a study of cowpea IPM in Uganda showed IPM knowledge was the most important variable in explaining the adoption of five IPM strategies (Erbaugh et al., 2007). Godtland and colleagues (2003) report that improved knowledge about IPM practices significantly impacted potato productivity. These results suggest that technical knowledge among FFS graduates is not only valuable as an outcome impact indicator, but could also serve as a reasonably reliable predictor of the adoption of management practices, particularly for crops and technologies where there is a relatively long time lag between adoption and impact.

2.6 Availability of Market and Adoption of Greenhouse Technology

Poorly functioning input and output markets erode the profitability of a technology to the farmer. In many places, a lack of infrastructure drives a wedge between the prices that farmers receive for their output and the market price, lowering the benefits from technology adoption. But investment in infrastructure is a public good, which results in underinvestment since those making the investment will not capture all the benefits (Jimenez 1995). Individual farmers' lack of market power, in combination with the lack of competition among input suppliers and among output intermediaries, leads to capture of much of the profit from improved technologies by market actors other than the farmer, which can lower technology adoption.

Institutional and infrastructure development is necessary to ensure broad-based, low cost market access, and well-functioning input and output marketing. Thus, rural farmers must have access to productive technologies and adequate private and public goods to participate into input and output marketing (Barrett, 2008). The key to expand marketing opportunities of developing countries is increasing agricultural product in international, regional, and domestic markets (World Bank, 2007). Thus, agricultural production is closely related to marketing, market access, and market development, whereas the poorly functioning of markets, weak domestic demand, and lack of export possibilities are the major constraints for agricultural growth (Diao and Hazell, 2004).

The global changes of rapid population growth, urbanization and market liberalization, impact directly on farming making it more market-oriented and competitive. Over the last three decades policies have changed to reduce the role of government in the economy and increase economic liberalization. This has led to new opportunities for farmers in developing countries to participate in the economy. Globalization and the increase of trade between nations have also offered some farmers opportunities to enter regional and international export markets. More freely operating markets require farmers to make more efficient use of scarce resources. But while economic liberalization and globalization have produced opportunities, they also carry risks. The challenge facing farmers is to adjust their farm-household systems to these changing market conditions and opportunities. On the output side, since the majority of smallholder farmers in the four countries are in subsistence production, marketing is underdeveloped and inefficient. Adequate storage facilities constitute another constraint to both marketing and food security.

In Africa large quantities of agricultural commodities produced by farmers tend to rot away un-marketed, while small scale farmers do not have the technology for timely consumption (kamara, *et al*, 2002). An additional key constraint on the output side to raising the productivity of small holder farmers in east Africa has been the inability of most of them to get linked into the supermarket chains. The main barrier is that they cannot meet the high quality and safety demands as well as delivery schedules that international value chain require, preventing them to compete in such markets.

The issue of market access by smallholder farmers cannot be addressed completely without taking a holistic perspective that also takes into account the global trends in economic transformation that have a direct bearing on the current smallholder market access situation. The forces of globalization and industrialization in agriculture have prompted new ways of organizing the agro-food sector. Vertical co-ordination of food supply chains has attracted a great deal of attention. The changes in food and agricultural markets have influenced the need for higher levels of managed co-ordination. This has resulted in the introduction of different forms of vertical integration and alliances, which have become a dominant feature of agricultural supply chains (Kirsten & Sartorius, 2002). Reardon and Barrett (2000) revealed how these changes have caused small firms and farms to go out of business under the new competitive pressures. The new competitive environment leads to industrial concentration, with practices that result in the exclusion of domestic firms and small farmers from the benefits and rewards of the high-value markets.

International experience has shown changes in global trends, implying new approaches and changes of focus by smallholder farmers. Many scholars (Boehlje, 2000; Drabenstott, 1995; Sofranko, Frerichs, Samy & Swanson, 2000) have argued that the most dramatic changes in agriculture are taking place in terms of changes in the fundamental business proposition and the ways of doing business: from producing for self-sufficiency to producing in a market-oriented way; from operating individually to operating in co-operatives; from staple crops to high-value crops and value-adding; from spot-market farming to contract farming; from traditional chains to modern value chains; from a focus on production output to a focus on commercialization; from marketing to low-profit markets to marketing to high-value markets; from supply-driven to demand-driven production (consumer satisfaction); from survivalist to entrepreneurship; and from a focus on conventional farming only to greenhouse farming as well.

Multiple studies cite unreliable supply and high prices of fertilizer and other inputs as primary barriers to adoption. Farmers who would benefit from adoption of agricultural technologies may be unable to access or to pay for the technology due to inadequate infrastructure, missing supply chains or unprofitably high prices. In many settings, farmer

organizations can enhance smallholder competitiveness in larger markets, as demonstrated by their rapid expansion in many developing countries over the past two decades (World Bank 2008). However, the challenges faced by these organizations are numerous and include legal restrictions, low managerial capacity, elite capture, exclusion of women and the poor (Baser 1998), and a lack of recognition by the state. Producer organizations may lack the capacity to fill the roles demanded by output purchasers, such as quality and quantity assurance, regulating the timing of output delivery and assembling products for sale.

Public sector involvement in input and output markets may be necessary to overcome unprofitable conditions, though government service provision has the potential to create a barrier to private sector entry due to threat of future regulation or distortions on demand. Much public sector involvement in input and output markets happens through agricultural extension services, which suffer from poor economies of scale and weak incentives for extension agents. Barriers to effective extension provision include large geographic areas of coverage exacerbated by poor infrastructure and microclimate variation, and difficult to trace impacts that create accountability problems (Feder et al. 2001). On the demand side, individual small-scale farmers may not recognize the potential benefits offered by extension, have limited purchasing power, and may not be organized to access services. On the supply side, few institutions are capable of providing technical extension services and the private sector may find extension services unprofitable because of the difficulties in charging for information or training that can easily spread beyond the immediate recipient (Anderson and Feder 2007).

In spite of the challenges to private sector value chains, many developing countries are undergoing a transformation of their agricultural markets as downstream purchase is consolidated through the rise of supermarkets and the lowering of trade barriers for agricultural exports (Reardon and Timmer 2007).

2.7 Technology Characteristics and Adoption of Greenhouse Technology

Characteristic of a technology is a precondition of adopting it. Trialability or a degree to which a potential adopter can try something out on a small scale first before adopting it completely is a major determinant of technology adoption (Doss, 2003). In studying determinants of adopting Imazapyr-Resistant maize (IRM) technology in Western Kenya, Mignouna et al. (2011) stated that, the characteristic of the technology play a critical role in adoption decision process. They argued that farmers who perceive the technology being consistent with their needs and compatible to their environment are likely to adopt since they find it as a positive investment. Farmers' perception about the performance of the technologies significantly influences their decision to adopt them. A study by Adesina and Zinnah (1993) showed that farmers' perception of characteristic of modern rice variety significantly influenced their decision to adopt it. A similar result was reported by Wandji et al. (2012) when studying perception of farmers towards adoption of Aquaculture technology in Cameroon. Their study indicated that perception of farmers towards fish farming facilitated its uptake. It is therefore important that for any new technology to be introduced to farmers, they should be involved in its evaluation to find its suitability to their circumstances (Karugia et al., 2004).

According to Loevinsohn et al. (2013), farmers' decisions about whether and how to adopt new technology are conditioned by thedynamic interaction between characteristics of the technology itself and the array of conditions and circumstances. Diffusion itself results from a series of individual decisions to begin using the new technology, decisions which are often the result of a comparison of the uncertain benefits of the new invention with the uncertain costs of adopting it (Hall and Khan, 2002). An understanding of the factors influencing this choice is essential both for economists studying the determinants of growth and for the generators and disseminators of such technologies (Hall and Khan, 2002).

A key determinant of the adoption of a new technology is the net gain to the farmer from adoption, inclusive of all costs of using the new technology (Foster and Rosenzweig, 2010). The cost of adopting agricultural technology has been found to be a constraint to technology adoption. For instance, the elimination of subsidies on prices of seed and

fertilizers since the1990s due to the World Bank-sponsored structural adjustment programs in sub-Saharan Africa has widened this constraint (Muzari *et al*., 2013). Previous studies on determinants of technology adoption have also reported high cost of technology as a hinderance to adoption. The study done by Makokha *et al*. (2001) on determinants of fertilizer and manure use in maize production in Kiambu county, Kenya reported high cost of labor and other inputs, unavailability of demanded packages and untimely delivery as the main constraints to fertilizer adoption. Cost of hired labor was also reported by Ouma *et al*. (2002) as one among other factors constraining adoption of fertilizer and hybrid seed in Embu county Kenya. Wekesa *et al.* (2003) when analyzing determinants of adoption of improved maize variety in coastal lowlands of Kenya found high cost and unavailability of seeds as one of factors responsible for low rate of adoption.

Off farm income has been shown to have a positive impact on technology adoption. This is because off-farm income acts as an important strategy for overcoming credit constraints faced by the rural households in many developing countries (Reardon *et al*., 2007). Off-farm income is reported to act as a substitute for borrowed capital in rural economies where credit markets are either missing or dysfunctional (Ellis and Freeman, 2004; Diiro, 2013). According to Diiro (2013) off- farm income is expected to provide farmers with liquid capital for purchasing productivity enhancing inputs such as improved seed and fertilizers. For instance, her study when analyzing the impact of off-farm earnings on the intensity of adoption of improved maize varieties and the productivity of maize farming in Uganda, Diiro reported a significantly higher adoption intensity and expenditure on purchased inputs among households with off-farm income compared to their counterparts without off-farm income. However not all technologies has shown positive relationship between off-farm income and their adoption. Some studies on technologies that are labor intensive have shown negative relationship between off-farm income and adoption. According to Goodwin and Mishra (2004) the pursuit of off-farm income by farmers may undermine their adoption of modern technology by reducing the amount of household labor allocated to farming enterprises.

The characteristics of the technology itself are also an important influence on farmers' technology adoption and usage decisions (Adesina and Zinnah, 1993). In particular, the relative complexity, risk and investment characteristics of technologies significantly affect their adoption and diffusion (Batz et al, 1999). Looking at the differences between capital-intensive and management-intensive technologies, El-Osta and Morehart (2002) found that age, size and specialization in dairy production increased the likelihood of adopting a capital-intensive technology, whereas education and size of operation positively impacted the decision to adopt a management-intensive technology. In this context, the risk preferences of farmers are also important ininfluencing the technology adoption decision, especially if capital-intensive technology costs are irreversible
(Sunding and Zilberman, 2001).

2.8 Theoretical Framework

This section outlined the theoretical framework used in the study 'Factors influencing adoption of greenhouse technology among small scale horticulture farmers in Gem sub-county, Kenya'. This study adopted Innovation diffusion theory advanced by Rogers (1995) supported by Hohenheim Diffusion Concept.

2.8.1 Innovation Diffusion Theory

This section outlined the theoretical framework used in the study 'Factors influencing adoption of greenhouse technology among small scale horticulture farmers in Gem sub-county, Kenya'. This study adopted Innovation diffusion theory advanced by Rogers (1995) supported by Hohenheim Diffusion Concept.

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, access to financial capital, technical skill, market availability and technology characteristics were regarded to be factors that affect the adoption of greenhouse technologies among small scale farmers in Gem Sub-County

The innovation diffusion model has several limitations. One of the major shortcomings of the model is that it generally assumes that the most important variable is information and the willingness of the individual to change. An individual is characterized according to his behavior without considering factors that influence his behavior. In reality many other factors are known to influence the adoption of an agricultural innovation. These include the farmer's objectives, the level of the resource endowments of the individuals, access to resources, availability of support systems and the characteristics of the innovation.

2.8.2 Hohenheim Diffusion Model

Like Rogers (2003), Hoffmann (2005) in this model includes more an incentive by looking at the dissemination stages and in addition qualities of adopters who fall in the different periods of dispersion as takes after:

The trend-setter as a troublemaker: The principal individual to rehearse a development in a social framework is called a trend-setter (Hoffmann 2005). Hoffmann (2006) additionally qualifies the pioneer at this beginning time as one who encounters an issue for which he will get a kick out of the chance to discover an answer. Once more, his movement isn't just observed as weird yet a sign that their strategies are antiquated and obsolete. The general population at that point set up their barrier component dismissing the development and the trend-setter and seeing him as a troublemaker (2005).

The basic stage: While Rogers (2003) terms the second class of adopters the early adopters, Hoffmann (2006) adds to this by naming this stage "the basic stage". He focuses on that not every person responds contrarily to the trend-setter (for example, nursery innovation promoters).Some either in light of their closeness to him as companions, relatives, and so on., keep contact and hold back their question and dismissal. Some observe themselves in a similar circumstance with the trend-setter.Transition to self-sustaining process: At this stage, what is presently new will be the future standard. While the initial couple of adopters make the action alluring, selection by persuasive people acquire another dynamism into the procedure. A degenerate conduct with respect to the trend-setter as at first respected is presently felt to be another approach. At this stage, ranchers may never again sufficiently check whether the development is useful or not subsequently there is expanded danger of confused selection of the advancement. This stage is synonymous to the early greater part class said by Rogers (2003) as made out of ponder adopters of the presented advancement.Final phase of the wave: While Rogers (2003) isolates this gathering in his hypothesis to Late larger part and Laggards, Hoffmann (2005) essentially term the two classes as the Final period of the wave. He specifies that if the advancement is accepted not to be similarly fitting and invaluable for all concerned, the appropriation rate sinks gradually and step by step in the wake of achieving the pinnacle. Similarly as the pioneer from the beginning was nearest to the development and the first to receive, there are currently individuals for whom restraining powers are far more grounded than the main thrusts. It is accepted along these lines that every single potential adopter, if grouped by their example of mental powers in connection to the choice on appropriation, as in Rogers (2003), this will frame around a typical dissemination yet with four stages in the dispersion procedure instead of five stages on account of Rogers (2003).

2.9 Conceptual Framework

The conceptual framework presented was developed from the literature review and it depicted how the study has been developed. The framework contained the conceptual model which schematically showed the expected relationships between the different variables.

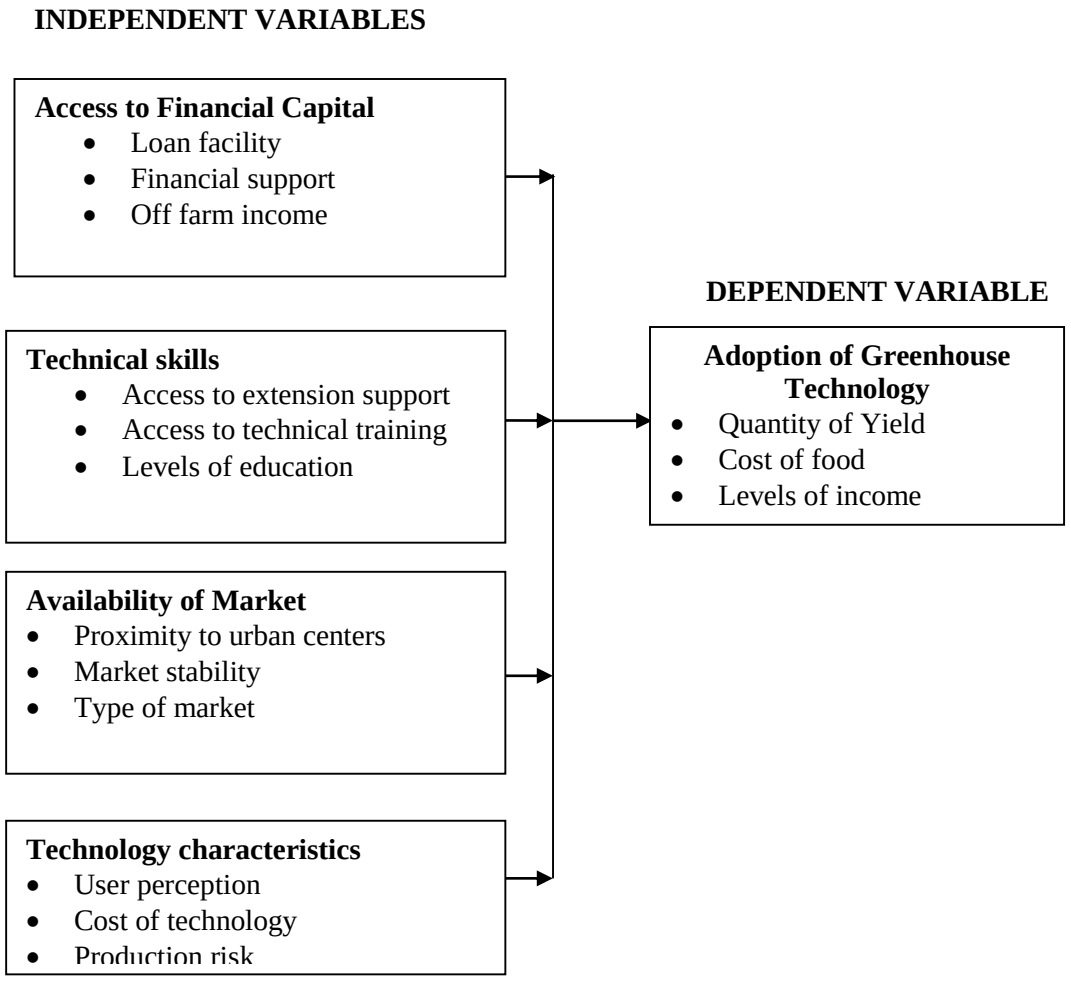


Figure 2.1: Conceptual Framework.

As is figure 2.1, a conceptual framework helps in verbalizing the interplay among various variables used in the study. In this study, the conceptual framework is based on four objectives; access to financial capital, technical skills and knowledge, access to output markets and technology characteristics. These factors are said to have a significant impact on the levels of greenhouse farming technology adoption among small scale farmers. Levels of greenhouse farming technology adoption was measured in terms of; poverty levels, levels of income, cost of food and quantity of yields. Access to financial capital was

measured in terms of income levels, financial support and access to loan facility. Technical skills was measured in terms of extension support, level of education and technical training. Availability of market was measured in terms of proximity to urban centers, market stability and point of sale. Technology characteristics was measured in terms of user perception, cost of technology and perceived risk. Moderating variable will also come into play as illustrated in figure 2.1. Government policies as a moderating arises in ensuring that access to loan facility is done within the legal framework, an effective extension service delivery model is in place and market players are on a level ground where prices are dictated by demand and supply.

2.10 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 Country is low. A study by Kinyangi (2014) also revealed that agricultural technology adoption among small scale farmers in Kakamega North Sub-County was low. This study intended to bridge this gaps by looking at specific factors that are likely to impede technology adoption process among small scale farmers such as access to finance, technical skills, education levels and technology characteristics. Therefore, this study sought to examine factors influencing the adoption of greenhouse technology among small scale farmers in Gem Sub-County, Kenya.

2.11 Summary of Literature Review

Literature review looked at general and empirical literature in order to capture all relevant information concerning the factors influencing adoption of greenhouse technology among smallholder farmers and determine the existing gaps. General literature attempted to look at how adoption of greenhouse technology can be influenced by access to financial capital, market availability, technical skills and technology characteristics. Review revealed that adoption of greenhouse technology can contributes significantly to economic growth of smallholder farmers. However in developed countries, the adoption of greenhouse technology has been higher as compared to developing countries.

Locally, literature reviewed adoption of greenhouse technology in Kenya specifically Gem sub-county, Siaya County. The study effectively identified the factors that hinder greenhouse technology adoption among small scale farmers in Gem sub-county. It focused on access to financial capital, availability of market, technical skills and technology characteristics as the key factors influencing adoption of greenhouse technology in Gem sub-county.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology that was used to conduct the study and provides a general framework for this research. This includes the research design, the target population, sample size and sampling procedure, research instruments for data collection, the research process, validity and reliability of research instruments as well as data processing and analysis techniques and ethical considerations.

3.2 Research Design

This study adopted a descriptive survey research design. This design was appropriate because the study sought to establish the nature of existing situation, establish the relationship among variables at only one point in time. In this study, effort was be made to establish the relationship between factors influencing the adoption of greenhouse farming technology among small scale farmers in Gem sub-county.

A descriptive survey was used to describe characteristics of variables; analyze their frequency, distribution and observable phenomena of the study population. Descriptive surveys employ the use of questionnaires and interviews as the primary means of collecting data. It also improves both internal and external validity and the realism of context thereby reducing risk of false exclusion (Cooper & Schindler, 2011). The design is the most recommended for business and sociological studies (Leedy, 1997). Other researchers that have used this design are Aosa (1992), Ongore (2011) and Munyoki (2007) to test hypothesis and draw conclusions. Advantages associated with descriptive surveys include ease of establishment of association between variables and comparison, possibility of administration of questionnaires to many people and anonymous completion of questionnaires.

3.3 Target Population

The target population for this study consisted of all small scale horticulture farmers in Gem Sub-County. From the records of Siaya County's directorate of Agriculture, there are 37,203 small scale horticulture farmers in Gem Sub County.

3.4 Sample Size and Sampling Procedure

This sub-section will discuss the sample size and sampling procedure that will be used in the study.

3.4.1 Sampling Size

To obtain the desired sample, a simplified formula for the proportions by Yamane (1973) was adopted. The formula was adopted assuming a 95% of confidence level and precision of 0.05.

According to the model:

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

where;

n - Sample size

N - Target population size = 372031

e - Precision level (at 0.95 confidence interval. e = 0.05)

Given N =37,203

$$n = \frac{37203}{1+37203(0.05^2)}$$

$$= 395$$

3.4.2 Sampling Procedure

This study employed both probability and non-probability sampling techniques. Concerning the probability sampling, Systematic random sampling was used to select open field horticulture farmers who have never practiced greenhouse farming within Gem Sub-county. This was achieved by assigning each farmer a random number in the range of 1 to 1000. The researcher then used systemic random sampling to pick every 3rd member after selecting the first through simple random sampling. The researcher preferred this procedure because was representative of population and more precise (Kothari, 2004)

The non-probability technique that was used is purposive sampling. The researcher used purposive sampling to handpick all the 80 small scale farmers practicing Greenhouse farming because they had in-depth information required with respect to the objectives of the study.

3.5 Data Collection Instruments

The study adopted a semi-structured questionnaire to collect primary data. The questionnaire was selected for this study because it is easy to administer, relatively inexpensive and data can be collected from a population that is geographically diverse. After developing the questionnaire, the researcher discussed this tool with the supervisors for concurrence before carrying out a pilot study and actual data collection. The questionnaire was divided into five sections. Section A focused on general information; section B focused on access to financial capital and adoption of greenhouse technology; section C focused on technical skills and adoption of greenhouse technology; section D focused on market availability and adoption of greenhouse technology and section E focused on technology characteristics and adoption of greenhouse technology.

3.6 Pilot Testing

To determine the feasibility of this study, a pilot study was conducted in Kisumu west Sub-County. The research questionnaires were administered to 30 small scale horticulture

farmers who were not involved in the main study. This was done before using the questionnaires to collect data in the field. The aim was to refine the questionnaires by testing its strengths and weakness followed by adjusting where necessary. Pre-testing the questionnaire helped to iron out vague questions that would generate ambiguous responses and rephrasing questions using comments by the respondents and providing enough writing space. In addition to the pilot study, a few copies of the questionnaire were analyzed to determine the appropriateness and sustainability of the methods of data analysis (Mugenda and Mugenda, 1999).

3.7 Validity of the Instruments

To ensure validity of the research instruments, this study employed both face and content validity, the researcher developed an evaluation form to help respondents asses each question using Likert scale, in terms of clarity of the wording, the likelihood the audience would be able to answer the questions and the layout and style of the questionnaire (Mohamad, Lisa, Sern, and Mohd, 2015). To accomplish content validity, the researcher sought opinion from experts, scholars and the supervisors concerning the structure and the content of the instruments (Kothari, 2004). From their comments, the researcher revised the unclear and ambiguous questions.

3.8 Reliability of Instruments

To ensure reliability of the instruments, the researcher employed test-retest reliability and internal consistency reliability methods of measurement. Test-retest reliability was estimated by administering the questionnaire to 15 respondents in an interval of two weeks apart during pilot survey and then correlating their scores. Internal consistency reliability was tested using Crobach's alpha correlation coefficient. Internal consistency examines the inter-item correlations within an instrument and indicates how well the items fit together conceptually (Parsian, 2009). Cronbach's alpha was computed by correlating the score for each scale item with the total score for each individual survey respondent and then comparing that to variance for all individual item scores. The reliability coefficient of equal or above 0.70 is considered satisfactory hence the adoption of the research instrument for

the study (Parsian, 2009). The cronbach's alpha results from the research pilot study are shown in table 3.1.

Table 3.1 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.987	**.988**	**15**

In this case, $\alpha = .987$, which shows the questionnaire is reliable.

3.9 Data Collection Procedures

Data collection procedure was categorized into three parts; pre-field work, field work and post field work. In pre-field work, the researcher identified the study area and topic for the study after a comprehensive writing of the research project proposal, the research sought for authorization from National Commission for Science, Technology and Innovation to be able to conduct the field study in Gem Sub-County. The research instruments were identified and discussed with the supervisor before being pre-tested. Pre-testing was done in Kisumu West Sub-County using a randomly selected group of 30 respondents. The questionnaires were distributed to the sample size population using random sampling technique. The questionnaires were administered by the researcher and research assistants through drop, wait and collect. Finally post field work was conducted in which the data collected from the field was recorded, presented, interpreted and analyzed for the study findings and conclusions. Data collection procedures refer to the protocol that must be followed to ensure that data collection tools are applied correctly (Mugenda, 2008).

3.10 Data Analysis Techniques

The study employed several steps in the analysis of data. The first step was to re-check the returned questionnaires for completeness, followed by labelling to ensure that confidentiality and anonymity of the respondents was maintained. The study applied both qualitative and quantitative approaches to process, analyze and interpret the data. In quantitative data analysis, descriptive analysis of mean and standard deviation was used

with the aid of Statistical Package for Social Sciences (SPSS) software version 20. The analyzed data was presented in form of percentages, means, standard deviation and frequency distribution tables

3.11 Ethical Consideration

Attention was paid to the principal of voluntary participation and the requirement of informed consent was be upheld throughout the study period. Essentially therefore, prospective respondents were fully informed about the purpose of the study and their consent to participate was sought. The respondents were assured of the confidentiality of information given and were informed that their views were to 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).

Table 3.2: Operationalization Table

Objective	Type of Variable	Indicators	Levels of scale	Approach of analysis	Types of analysis	Level of Analysis
To assess how access to financial capital influences adoption of greenhouse technology among small scale horticulture farmers.	**Independent Variable** Access to financial capital	- Access to loan facility - Financial support -Off farm income	Ordinal	-Descriptive -Interview Questionnaire	Quantitative and Qualitative	Descriptive
	Dependent variable Adoption of greenhouse technology	- Levels of poverty	Ordinal	-Descriptive -Interview -Questionnaire	Quantitative and Qualitative	Descriptive
To establish the extent to which technical skills and knowledge of greenhouse influences the adoption of greenhouse technology	**Independent variable** Technical skills and knowledge	-Extension support -Access to technical training -Education level	Ordinal	-Descriptive -Interview -Questionnaire	Quantitative and Qualitative	Descriptive
	Dependent variable Adoption of greenhouse technology	-Quantity of yield	Ordinal	-Descriptive -Interview -Questionnaire	Quantitative and Qualitative	Descriptive
To establish the extent to which availability of market influences the adoption of greenhouse technology	**Independent variable** Access to output market	-Type of market -Market stability -Proximity to market	Ordinal	-Descriptive -Interview -Questionnaire	Quantitative and Qualitative	Descriptive
	Dependent variable Adoption of greenhouse technology	-Cost of food	Ordinal	-Descriptive -Interview -Questionnaire	Quantitative and Qualitative	Descriptive
To determine the extent to which technology characteristics influences the adoption of greenhouse technology	**Independent variable** Entrepreneurial skills	-User perception -Perceived risk -Cost of technology	Ordinal	-Descriptive -Interview -Questionnaire	Quantitative and Qualitative	Descriptive
	Dependent variable Adoption of greenhouse technology	-Adoption rates	Ordinal	-Descriptive -Interview -Questionnaire	Quantitative and Qualitative	Descriptive

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

This chapter presents data analysis, presentation, interpretation and discussion of study findings in line with study objectives. The sections within this chapter includes: - Questionnaire response rate, Demographic information of respondents, and analysis based on key thematic and sub-thematic areas in line with the objectives of the study. The key thematic areas were access to financial capital and adoption of Greenhouse technology, Technical skills and adoption of greenhouse technology, Availability of markets and adoption of greenhouse technology and Technology characteristics and adoption of greenhouse technology.

4.2 Questionnaire Return Rate

Out of 395 questionnaires administered to small scale horticulture farmers, 246 were duly filled giving a response rate of 62%. Further, the researcher and the research assistants ensured that completed questionnaires were collected back and respondents who were not willing to participate in the study were excluded from taking part and that only the ones who accepted took part in the study. According to Mugenda and Mugenda (2003), 50% response return rate is good for a study.

Table 4.0: Questionnaire Return Rate

Questionnaire issued	Questionnaire returned	Incomplete Questionnaires	Complete Questionnaires	Response rate
395	259	13	246	62%

4.3 Demographic Characteristics of Respondents

This sub-section presents the data findings on the respondent's demographics. The specific indicators analyzed included; Gender, Age group, Level of education, and involvement in greenhouse farming.

4.3.1 Distribution of Respondents by Gender.

Gender is an important variable in any given African social setup which is variably affected by any social or economic phenomenon and globalization is not an exception to it. Hence the variable gender was investigated for this study. Data related to gender of the respondents is presented in the Table 4.1.

Table 4.1: Distribution of Respondents by Gender

	Distribution of respondents	
GENDER	**Frequency**	**Percent**
Male	152	62
Female	94	38
Total	246	100

Results indicated that majority of the respondents 152 (62%) were male while 94 (38 %) were female. This implies there was gender imbalance in the manner in which male and female practice horticulture farming in Gem sub-county. The explanation could be that males take a lead role in determining the farming enterprises their household members engage in. Another reason can be Gender roles where male members of the household are associated with field work while women attend to house chores.

4.3.2 Distribution of Respondents by Age

Age of the respondents is one of the most important characteristics in understanding their views about the particular problems; by and large age indicates level of maturity of individuals in that sense age becomes more important to examine, the results are shown in Table 4.2.

Table 4.2: Distribution of Respondents by Age

AGE	Distribution of respondents	
	Frequency	**Percent**
Less than 25	42	17
25 – 34	61	25
35 – 44	56	23
45 – 54	47	19
Above 55	40	16
Total	**246**	**100**

The research findings indicated that 42 (17%) of the respondents were less than 25 years, 61 (25%) aged between 25 – 34; 56 (23%) aged between 35 – 44; 47 (19%) aged between 45 – 54 and 40 (16%) above 55 years. The findings on respondents distribution by age was significant to this study as majority of the respondents were household aged between 25-34 years implying that the respondents were relatively of the middle age and household aged between 35-44 years implying that respondents were above the middle age with a few 5 (1.2%) falling above 55 years. The Majority of the respondents were in the middle age which is associated with high level of productivity and personal growth. Age also indicated that most of the respondents who participated in the study were mature and therefore age was more important in examining their responses. This information was important for this study since the researcher was interested in determining the respondent's level of engagement in greenhouse farming.

4.3.3 Distribution of Respondents by Level of Education

Education is one of the most important characteristics that might affect the person's attitudes and the way of looking and understanding any particular social phenomena. In a way, the response of an individual is likely to be determined by his educational status and therefore it becomes imperative to know the educational background of the respondents. Hence the variable 'Educational level' was investigated by the researcher and the data pertaining to education is presented in Table: 4.3

Table 4.3: Distribution of Respondents by Level of Education

	Distribution of Respondents	
LEVEL OF EDUCATION	**Frequency**	**Percent**
Never been to school	0	0
Primary	36	15
Secondary	118	48
College/University	92	37
Total	**246**	**100**

The research findings indicated that 92 (37%) attained college/university, 118 (48%) had secondary level of education, 36 (15 %) had primary level of education and none of the respondents had not attained any level of education at all. On the basis of levels of education, it was established that 210 (85%) of the respondents had attained either secondary or college education. A majority of the respondents were literate. It can be concluded from the Table above that by and large most of the respondents were educated and were therefore able to interpret and respond appropriately to the questionnaire.

4.3.4 Distribution of Respondents by Level of Involvement in Greenhouse Farming

Assessing level of involvement in greenhouse farming was critical to this study since the researcher was interested in determining factors that influence the greenhouse technology adoption rates.

Table 4.4: Distribution of Respondents by Adoption of Greenhouse Farming

	Distribution of respondents	
ADOPTION	**Frequency**	**Percent**
Practicing	85	35
Not practicing	161	65
Total	**246**	**100**

The findings indicated that majority of the respondents 161(65%) had not adopted greenhouse farming while a minority 85 (35%) were practicing. It was clear from the findings that greenhouse farming technology adoption level was still low, this was important for the researcher to since this research was interested in establishing the factors influencing adoption rates.

4.4 Access to Financial Capital and Greenhouse Technology Adoption

The study sought to find out to what extent access to financial capital influences adoption of greenhouse farming technology. To answer this, the respondents were asked to state the influence of access to loan facility, financial support and their income levels on adoption of greenhouse technology. The results are recorded in table 4.5; 4.6 and 4.7 respectively

4.4.1 Access to Loan Facility and Adoption of Greenhouse Technology

To find out the influence of access to loan on adoption of Greenhouse Farming, the respondents were asked to state in what ways access to loans contributed towards their adoption of greenhouse farming. The results are presented in table 4.5.

Table 4.5: Access to Loan Facility on Adoption of Greenhouse Technology

Statements	SD F(%)	D F(%)	N F(%)	A F(%)	SA F(%)	Mean	Standard deviation
Greenhouses are too expensive for small scale farmers to afford in cash.	5 (1.9)	19 (7.3)	12 (4.6)	104 (39.8)	106 (40.6)	**1.83**	**.973**
Smallholder farmers in this area have access to loan facility from financial institutions to invest in farming	112 (42.9)	102 (39.1)	8 (3.1)	21 (8.0)	3 (1.1)	**1.78**	**.947**
Average						**1.81**	**.960**

The cumulative score in Table 4.5 showing the mean = 1.81 and the standard deviation = 0.960 indicate that access to loan facility influenced adoption of greenhouse farming technology with low variation in opinion by all the respondents regarding this construct. This is supported by the responses that shows that 106 (40.6%) strongly agreed that greenhouses are too expensive for small scale farmers to afford in cash with a mean of 1.83 and standard deviation of 0.973. The findings also indicated that another 121 (42.2%) of the respondents strongly disagreeing that small scale farmer have access to loans from financial institutions to invest in farming with a mean score of 1.78 and a standard deviation of 0.947. From this table it is clear that access to loan facility was key in adoption of greenhouse technology. The low access to loans can be attributed to the high collateral requirement by lending institutions inhibiting farmers from accessing credit or limiting credit amount granted in relation to the amount of credit demanded. This findings are in concurrence with the findings by Diagne and Zeller (2001) that the credit limits granted by

formal lenders in Malawi were relatively small in relation to the amount of credit demanded. Zeller and Diagne (2001) therefore recommend to gradually increase loan sizes to repeat borrowers.

4.4.2 Financial Support and Adoption of Greenhouse Technology

The study also investigated lack or presence of financial support to small scale farmers. The respondents were asked to state whether they had received any form of financial support to assist them in financing greenhouse farming. The results were presented on table 4.6.

Table 4.6: Financial Support on Adoption of Greenhouse Technology

The aggregate score in Table 4.6 indicating the mean = 3.76 and a standard deviation =

Statements	**SD F(%)**	**D F(%)**	**N F(%)**	**A F(%)**	**SA F(%)**	**Mean**	**Standard deviation**
Small scale farmers in Gem sub-county have access to grants for greenhouse farming	52 (21.1)	108 (43.9)	0 (0)	54 (22.0)	32 (13.0)	**3.38**	**1.373**
Small scale farmers in Gem sub-county have access to donor funding for greenhouse farming.	99 (40.2)	118 (48.0)	0 (0)	21 (8.5)	8 (3.3)	**4.13**	**1.011**
Average						**3.76**	**1.192**

1.192 shows that a majority of the respondents were in agreement that financial support influence the adoption of greenhouse farming technology and there was minimal variations in opinion regarding this construct. This is supported by the findings that 108 (43.9%) of small scale farmers disagreed with the statement that small scale farmers had access to grants for greenhouse farming with a mean of 3.38 and a standard deviation of 1.373. Another 118 (48%) disagreed with the statement that small scale farmers have access to donor funding for greenhouse farming. From this table it is clear that small scale farmers in Gem sub-county had no access to financial support inform of grants or donor funding to

start greenhouse farming. It is clear that there are no institutions such as Non-governmental organizations supporting small scale farmers in financing their farming activities or other credit entities offering direct support to the farmers.

4.4.3 Income Levels and Adoption of Greenhouse Technology

The study also investigated income levels of small scale farmers. The respondents were asked to state whether they had any other sources of income apart from farming that would assist them in financing greenhouse farming. The results were presented on table 4.7.

Table 4.7: Income Levels on Adoption of Greenhouse Technology

Statements	**SD F(%)**	**D F(%)**	**N F(%)**	**A F(%)**	**SA F(%)**	**Mean**	**Standard deviation**
Small scale farmers have other non-farm sources of income	42 (17.1)	68 (27.6)	6 (2.4)	89 (36.2)	41 (16.7)	**2.92**	**1.411**
Small scale farmers in Gem sub-county are engaged in other gainful employment	43 (17.5)	52 (21.1)	4 (1.6)	101 (41.1)	46 (18.7)	**2.78**	**1.424**
Average						**2.85**	**1.418**

Looking at the findings of Table 4.7, indicating an average mean score = 2.85 and a standard deviation = 1.418 which implies that levels of income did not influence adoption of greenhouse technology. This is supported by the findings that 89 (36.2%) and 41 (16.7) of small scale farmers agreed with the statement that small scale farmers had other nonfarm sources of income with a mean of 2.92 and a standard deviation of 1.411. Another 101 (41.1%) and 46 (18.7 agreed with the statement that small scale farmers are engaged in other gainful employment. From this table it is clear that small scale farmers in Gem sub-county had other off farm sources of income and therefore did not depend entirely on farming as their sole source of income. These small scale farmers are either engaged in other gainful

employment or other income generating businesses. This findings concur with similar findings by Diiro, (2013) which suggested the off farm income may induce adoption of improved technologies although efficiency gains from adoption may be undermined by the more limited time that farmers with off farm income sources allocate to farm enterprises. Small scale farmers with other sources of income will therefore be in a constant struggle to strike a balance between their farming enterprises and other sources of income.

4.5 Technical Skills and Adoption of Greenhouse Technology

The study sought to investigate the effects of technical skills on adoption of greenhouse technology. To achieve this, the respondents were asked to state their opinion on access to extension support, technical training and education levels on adoption of Greenhouse farming technology. Results are presented on table 4.8; 4.9 and 4.10

4.5.1 Extension Support and Adoption of Greenhouse Technology.

The opinion of respondents was sought to determine whether access to extension support influenced adoption of greenhouse farming technology. The results are recorded on table 4.8.

Table 4.8: Extension Support and Adoption of Greenhouse Technology

Statements	SD F(%)	D F(%)	N F(%)	A F(%)	SA F(%)	Mean	Standard deviation
Extension support system is reliable and efficient.	34 (13.8)	100 (41.7)	11 (4.5)	58 (23.6)	43 (17.5)	**3.39**	**1.288**
The cost of extension support is affordable to smallholder farmers	48 (19.5)	106 (43.1)	8 (3.3)	63 (25.6)	21 (8.5)	**2.76**	**1.357**
Average						**3.08**	**1.323**

Table 4.8 shows that 100 (40.7%) of the respondents disagreed with the statement that extension support was reliable and efficient with a mean of 3.39 and a standard deviation of 1.288. Another 106 (43.1%) of the respondents also disagreed with the statement that cost of extension support was affordable to smallholders with a mean of 2.76 and a standard deviation of 1.357. From this table it is clear that most of the mall scale farmers were not able to receive extension services because they are either unreliable and inefficient or too expensive for the small scale farmers to afford. This can be attributed to the few extension officers employed by the government and the demand driven extension approach used by the government. Private extension service providers may also be few and expensive for the small scale farmers to afford. This findings agree with findings of Hussain et al. (1994) which studied behavior of farmers in response to extension contact and found out that there is a direct relationship between extension practice and its impact on technology adoption behavior of farmers. They examined the impact of the Training and Visit (T&V) system on the adoption of improved wheat technology, and stated that training and visit had improved the farmers' knowledge and adoption of the technology. It is therefore important to strengthen and re-align the extension service provision system to respond to the need of small scale farmers

4.5.2 Technical Training and Adoption of Greenhouse Technology

The respondents were asked to give their opinions of technical training on adoption of greenhouse farming. The results are recorded on table 4.9.

Table 4.9: Technical Training and Adoption of Greenhouse Technology

Statements	SD F(%)	D F(%)	N F(%)	A F(%)	SA F(%)	Mean	Standard deviation
Farmers with technical skills on greenhouse management are more likely to adopt the technology.	8 (3.3)	11 (4.5)	7 (2.8)	121 (49.2)	99 (40.2)	**1.81**	**0.933**
Technical training in greenhouse farming is affordable to smallholder farmers.	55 (22.4)	119 (48.4)	5 (2.0)	49 (19.9)	18 (7.3)	**3.59**	**1.238**
Average						**2.70**	**1.086**

Table 4.9 shows that 121 (49.2%) of the respondents agreed with the statement that farmers with technical skills on greenhouse management are more likely to adopt the technology with a mean of 1.81 and a standard deviation of 0.933. Another 119 (48.4%) of the respondents disagreed with the statement that technical training in greenhouse farming was affordable to smallholder farmers. From this table it is clear that training farmers on technical management skills of greenhouses was likely to increase adoption rates, however most of the farmers found the cost of training expensive to afford. This can be attributed to lack of technical training institutions and the expensive cost of training that small scale farmers might not afford. This findings are supported by Gotland (2004), Using survey-data from Peru, Gotland evaluated the impact of a pilot farmer-field-school (FFS) program on farmers' knowledge of integrated pest management (IPM) practices related to potato cultivation. He found that farmers who participate in the program had significantly more knowledge about IPM practices than those in the non-participant comparison group. He

also found suggestive evidence that improved knowledge about IPM practices had the potential to significantly improving productivity in potato production. The government should therefore prioritize strengthening farmer field schools approach where farmers can gain practical skills. The government should also strengthen agricultural training centers by equipping them with highly skilled staff and training equipment's to respond to the real needs of the smallholder farmers.

4.5.3 Education and Adoption of Greenhouse Technology

The study sought to establish how respondent's education level influenced adoption of greenhouse. Respondents were asked to give their opinions of whether education levels influence adoption of greenhouse farming technology. Respondents gave answers which are presented in table 4.10

Table 4.10: Education Levels and Adoption of Greenhouse Technology.

Statements	**SD F(%)**	**D F(%)**	**N F(%)**	**A F(%)**	**SA F(%)**	**Mean**	**Standard deviation**
In your opinion, level of education accelerate adoption of greenhouse farming	40 (16.3)	67 (27.2)	4 (1.6)	91 (37.0)	44 (17.9)	**2.87**	**1.414**
The more one progresses in education, the higher the chances on adopting greenhouse farming technology	39 (15.9)	71 (28.9)	4 (1.6)	92 (37.4)	40 (16.3)	**2.91**	**1.395**
Average						**2.89**	**1.405**

Table 4.10 shows that 91 (37%) of the respondents were of the opinion that level of education accelerate adoption of greenhouse farming with a mean of 2.87 and a standard

deviation of 1.414. Another 92 (37.4%) of the respondents were also of the opinion that the more one progresses in education, the higher the likelihood of adopting greenhouse farming. With an aggregate mean score of 2.89 and a standard deviation of 1.405, it is evident that education levels influenced the adoption of greenhouse technology. This findings concur with with a study by Okunlola et al. (2011) on adoption of new technologies by fish farmers and Ajewole (2010) on adoption of organic fertilizers, both studies found that the level of education had a positive and significant influence on adoption of the technology. This is because higher education influences respondents' attitudes and thoughts making them more open, rational and able to analyze the benefits of the new technology. This eases the introduction of a new innovation which ultimately affects the adoption process (Adebiyi & Okunlola, 2010). It can be further argued that education enables farmers to be rational in making decisions and therefore they are able to evaluate the benefits of the technological choices they make.

4.6 Market Availability and Adoption of Greenhouse Technology

The study sought to find out the influence of market availability on greenhouse technology adoption. To achieve this, the respondents were asked to state their opinion in relation to proximity to urban centers, market stability and type of market

4.6.1 Proximity to Market and Adoption of Greenhouse Technology

The study sought to establish how proximity to market influence adoption of greenhouse technology. Respondents were asked to give their opinions of whether proximity to urban centers influence adoption of greenhouse farming technology. Respondents gave answers which are presented in table 4.11

Table 4.11: Proximity to Markets and Adoption of Greenhouse Farming.

Statements	SD F(%)	D F(%)	N F(%)	A F(%)	SA F(%)	Mean	Standard deviation
Smallholder farmers are exploited by middlemen due to distance from markets	9 (3.7)	29 (11.8)	6 (2.4)	121 (49.2)	81 (32.9)	**2.04**	**1.076**
Smallholder farmers suffer post-harvest losses due to distance to market	10 (4.1)	31 (12.6)	6 (2.4)	123 (50.0)	76 (30.9)	**2.09**	**1.096**
Average						**2.065**	**1.086**

Table 4.11 shows that 121 (49.2%) of the respondents agreed with the statement that small scale farmers are exploited by middlemen who act as a bridge to the final produce market with a mean of 2.04 and a standard deviation of 1.076. the table also shows that another 123 (50%) of the respondents agreed that small scale farmers suffer post-harvest losses due to distance to the markets with a mean of 2.09 and a standard deviation of 1.096. From this table it is clear that farmers are prone to losing their produce through post-harvest losses or disposal to middlemen who offer them lower prices for their produce. This findings concur with the findings by Tung and Costales (2007), their study assessed market participation of smallholder poultry producers and found that main market outlets were heavily influenced by proximity to market centers, with itinerant village traders gaining in importance as market outlet as scale of smallholder production increases. Itinerant traders were the main link between smallholder producers and consumers in larger urban centers, largely through informal market chains. The government must therefore invest in infrastructural development such as rural roads and storage facilities for small scale farmers to avert post-harvest losses and exploitation by middlemen.

4.6.2 Market Stability and Adoption of Greenhouse Technology

The study sought to establish how market stability influence adoption of greenhouse. Respondents were asked to give their opinions of whether market stability influence adoption of greenhouse farming technology. Respondents gave answers which are presented in table 4.12

Table 4.12: Market Stability and Adoption of Greenhouse Technology.

Statements	SD F(%)	D F(%)	N F(%)	A F(%)	SA F(%)	Mean	Standard deviation
Unstable produce markets discourages farmers from adopting greenhouse farming	15 (6.1)	36 (14.6)	6 (2.4)	120 (48.8)	69 (28.0)	**2.22**	**1.182**
Frequent fluctuation in market prices discourages farmers from adopting greenhouse farming.	18 (7.3)	37 (15.0)	5 (2.0)	118 (48.0)	68 (27.6)	**2.26**	**1.222**
Average						**2.24**	**1.202**

Table 4.12 shows that 120 (48.8%) of the respondents agreed with the statement that unstable produce markets discourages farmers from practicing greenhouse farming with a mean of 2.22 and a standard deviation of 1.182. The table also shows that another 118 (48%) of the respondents agreed that frequent fluctuation in market prices discourages farmers from adopting greenhouse farming. From this table it is clear that market stability is a major consideration for the small scale farmers when making decision to either adopt or dis-adopt agricultural technologies. This findings are in agreement by similar findings by Diao and Hazell, (2004), their study found that agricultural production is closely related to marketing, market access, and market development, whereas the poorly functioning of markets, weak domestic demand, and lack of export possibilities were the major constraints

for agricultural growth. To be able to maximize on the returns of the technology, farmers need stable markets for sale of their produce. It is notable that institutional and infrastructure development is necessary to ensure broad-based, low cost market access, and well-functioning input and output marketing.

4.6.3 Type of Outlet Market and Adoption of Greenhouse Technology

The study sought to establish how type of market influence adoption of greenhouse. Respondents were asked to give their opinions of whether type of market outlet influence adoption of greenhouse farming technology. Respondents gave answers which are presented in table 4.13

Table 4.13: Type of Outlet Market and Adoption of Greenhouse Technology

Statements	**SD F(%)**	**D F(%)**	**N F(%)**	**A F(%)**	**SA F(%)**	**Mean**	**Standard deviation**
Small scale farmers sell their produce majorly at the farm gate	45 (18.3)	54 (22.0)	4 (1.6)	102 (41.5)	41 (16.7)	**2.84**	**1.419**
Smallholder farmers sell their produce at the wholesale market	68 (27.6)	124 (50.4)	4 (1.6)	39 (15.9)	11 (4.5)	**3.81**	**1.139**
Average						**3.33**	**1.279**

Table 4.13 shows that 102 (41.5%) of the respondents agreed with the statement that agreed with the statement that small scale farmers sell their produce majorly at the farm gate with a mean of 2.84 and a standard deviation of 1.419. Another 124 (50.4%) disagreed with the statement that smallholder farmers sell their produce at the wholesale market with a mean of 3.81 and a standard deviation of 1.139. From this table it is clear that most of the farmers sell their produce at farm gate which is usually associated with lower prices. This findings

agree to those of Omiti et al. (2009), while assessing factors influencing the market participation of smallholder farmers in rural and peri-urban, Kenya. Their findings showed that farmers in peri-urban areas sold higher proportions of their output than those in rural areas. Distance from farm to point of sale is a major constraint to the intensity of market participation. Better output price and market information are key incentives for increased sales. These findings demonstrate the urgent need to strengthen market information delivery systems, upgrade roads in both rural and peri-urban areas, encourage market integration initiatives, and establish more retail outlets with improved market facilities in the remote rural villages in order to promote production and trade in high value commodities by rural farmers.

4.7 Technology Characteristics and Adoption of Greenhouse Technology

The study sought to investigate the effects of technology characteristics on adoption of greenhouse technology. To achieve this, opinion of respondents was sought in regards to user preference, cost of technology and perceived risks. Results are presented on table 4.14; 4.15 and 4.16.

4.7.1 User Perception and Adoption of Greenhouse Technology

The study sought to establish how user preference influence adoption of greenhouse. Respondents were asked to give their opinions of whether user preference influence adoption of greenhouse farming technology. Respondents gave answers which are presented in table 4.14

Table 4.14: User Perception and Adoption of Greenhouse Farming

Statements	SD F(%)	D F(%)	N F(%)	A F(%)	SA F(%)	Mean	Standard deviation
Smallholder farmers prefer greenhouse farming to open field	27 (11.0)	37 (15.0)	5 (2.0)	101 (41.1)	76 (30.9)	**2.34**	**1.345**
Greenhouse farming is more attractive compared to open field	27 (11.0)	36 (14.6)	4 (1.6)	103 (41.9)	76 (30.9)	**2.33**	**1.341**
Average						**2.34**	**1.343**

Table 4.14 shows that 101 (41.1%) of the respondents agreed with the statement that smallholder farmers prefer greenhouse farming to open field with a mean of 2.34 and a standard deviation of 1.345. The table also shows 103 (41.9%) agreeing that greenhouse farming is more attractive compared to open field. From this table it is clear that most of the small scale farmers prefer doing greenhouse farming to open field farming with a majority finding it attractive. This findings support a study by adesina and Zinnah (1993) their study showed that farmers' perception of characteristic of modern rice variety significantly influenced their decision to adopt it. A similar result was reported by Wandji *etal*. (2012) when studying perception of farmers towards adoption of Aquaculture technology in Cameroon. Their study indicated that perception of farmers towards fish farming facilitated its uptake. It is therefore important that for any new technology to be introduced to farmers, they should be involved in its evaluation to find its suitability to their circumstances.

4.7.2 Cost of Technology and Adoption of Greenhouse Technology

The study sought to establish how cost of technology influence adoption of greenhouse. Respondents were asked to give their opinions of whether cost of technology influence adoption of greenhouse farming technology. Respondents gave answers which are presented in table 4.15

Table 4.15: Cost of Technology and Adoption of Greenhouse Farming

Statements	SD F(%)	D F(%)	N F(%)	A F(%)	SA F(%)	Mean	Standard deviation
Greenhouse farming require huge capital to start	5 (2.0)	25 (10.2)	6 (2.4)	104 (42.3)	106 (43.1)	**1.86**	**1.014**
Greenhouses are too expensive for small scale farmers	8 (3.3)	33 (13.4)	7 (2.8)	124 (50.4)	74 (30.1)	**2.09**	**1.074**
Average						**1.975**	**1.044**

Table 4.15 shows that 106 (43.1%) of the respondents strongly agreed with the statement that Greenhouse farming require huge capital with a mean of 1.86 and a standard deviation of 1.014. The table also shows 124 (50.4) agreeing that greenhouses are too expensive for small scale farmers with a mean of 2.09 and a standard deviation of 1.074. From this table it is clear that most of the farmers might not be able to buy greenhouses because of the huge cost of buying which can ultimately lead to low adoption levels. This is in agreement with a study by El Oster and Morehart (1999), their study found that technologies that are capital intensive are only affordable by wealthier farmers and hence the adoption of such technologies is limited to larger farmers who have the wealth. Therefore adoption can be

expected to be dependent on cost of a technology and on whether farmers possess the required resources.

4.7.2 Production Risk and Adoption of Greenhouse Technology

The study sought to establish how perceived risk of technology influence adoption of greenhouse. Respondents were asked to give their opinions of whether perceived technological risk had influence on adoption of greenhouse farming technology. Respondents gave answers which are presented in table 4.16

Table 4.16: Perceived Risk and Adoption of Greenhouse Farming

Statements	**SD F(%)**	**D F(%)**	**N F(%)**	**A F(%)**	**SA F(%)**	**Mean**	**Standard deviation**
Greenhouse farming is so risky for smallholder farmers	27 (11)	77 (31.3)	6 (2.4)	79 (32.1)	57 (23.2)	**2.75**	**1.394**
Greenhouse farming is too complex for small scale farmers	12 (4.9)	73 (29.7)	4 (1.6)	101 (41.1)	56 (22.8)	**2.53**	**1.264**
Average						**2.64**	**1.329**

Table 4.16 shows that 101 (41.1%) of the respondents agreed with the statement that Greenhouse farming is too complex for small scale farmers with a mean of 2.75 and a standard deviation of 1.394. The table also shows 79 (32.1) agreeing that greenhouses farming is very risky. With an aggregate mean of 2.64 and a standard deviation of 1.329, it is evident that production risk had a direct influence on greenhouse technology adoption. This findings are supported by Maurice and Wilfred (2009), they studied the effects of production risk on farm technology adoption among small holder farmers using plot-level data collected from two semi-arid districts in Kenya, Machakos, and Taita Taveta. Their results showed that, among others, yield variability and the risk of crop failures indeed affect technology adoption decisions in low-income, rain-fed agriculture. But, the direction

and magnitude of effects depend on the farm technology under consideration. Their results explained why poor farm households in rain-fed and risky production environments were reluctant to adopt new farm technologies with potential production gain because, at the same time, they involved enormous downside risks. This result underscores the fact that productivity gains are necessary, but not sufficient, conditions to attract farmers to adopt new technologies and agricultural innovations. Risk implications matter. Technology- and location-specific production-risk coping strategies need to be designed to successfully upscale profitable farm technologies across poor farm households in low income countries.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of findings, conclusions and recommendations of this research study. The conclusions presented in this section were guided by the research objectives and informed by the findings, analysis, interpretation and discussion in the study. Finally suggestion for further research were made.

5.2 Summary of Findings

This section presents the main findings of the study

5.2.1 Demographic Characteristics of the Respondents

The results indicated that majority of the respondents were within the age brackets of 25-34 years (25%), followed by 35-44 years (23%) and lowest being above 55 years (16%). With regard to gender of the respondents, male dominated at 62% while female were 38%. In response to education levels of respondents, the highest majority at 48% had attained secondary education; 37% had College/University degrees and 15% having attained Primary certificate. None of the respondents had not gone to school. On the basis of whether the respondents had ever practiced greenhouse farming or not, 65% had never practiced while 35 had been engaged in greenhouse farming.

5.2.2 Financial Capital and Adoption of Greenhouse Technology

Objective one of the study sought to establish influence of access to financial capital on Greenhouse technology adoption in Gem Sub-County. Indicators for access to financial capital which were; Access to credit, financial support and income levels were assessed. The results demonstrate that 87% of the respondents reporting access to credit as a major factor influencing adoption, 76% reported that they would adopt greenhouse farming technology should they receive financial support. Another 56% indicated that their low levels of income was the greatest hindrance to greenhouse technology adoption. This

findings means that access to financial capital has a significant influence on greenhouse technology adoption.

5.2.3 Technical Skills and Adoption of Greenhouse Technology

Objective two of the study sought to establish the influence of technical skills on greenhouse technology adoption in Gem Sub-county. Indicators for technical skills assessed were; extension support, education, technical skills. The result demonstrate 58% reporting poor extension support system as a major factor affecting adoption rates, another 78% of respondents citing education as a major hindrance to greenhouse technology adoption. A further 54% pointed out lack of technical skills in managing greenhouse as the greatest hurdle to adoption of greenhouse technology. This findings therefore demonstrate that technical skills had a significance influence on greenhouse technology adoption.

5.2.4 Market Availability and Adoption of Greenhouse Technology

Objective three of the study sought to establish the influence of market availability on greenhouse technology adoption in Gem Sub-county. Indicators for market availability assessed were; type of market, proximity to urban centers and market stability. The results demonstrate that market instability was significant at 80%, proximity to urban centers was also cited at 76% while type of market was cited by 67%. This findings means that availability of market had a significance influence on greenhouse technology adoption.

5.2.5 Technology Characteristics and Adoption of Greenhouse Technology

Objective four of the study sought to establish influence of technology characteristics on greenhouse technology adoption. The results demonstrate that 71% of the respondents indicated that user perception had a significant influence in greenhouse technology adoption. Another 83% of the respondents reported cost as having influence on greenhouse technology adoption with 59% citing production risks as the major reason for slow adoption. The mixed findings imply that technology characteristics had influence on greenhouse technology adoption.

5.3 Conclusions

This section presents the conclusions for the study. The study made the following conclusions based on the four objectives.

Regarding objective one which sought to assess the influence of access to financial capital on adoption of greenhouse technology. The study concluded that access to financial capital, financial support and off farm income had direct influence on the rate of greenhouse technology adoption.

In answering objective two which sought to establish the extent to which technical skills influence greenhouse technology adoption among small scale farmers, the study concluded that access to extension support, access to technical training and individual levels of education had direct influence on the rate of greenhouse technology adoption at varying degrees.

In respect objective three which sought to establish the extent to which availability of market influences adoption of greenhouse technology among small scale farmers, the study concluded that proximity to urban centers, market stability and type of market outlet had a direct influence on the rate of greenhouse technology adoption.

Concerning the fourth objective which sought to determine the extent to which technology characteristics influence the adoption of greenhouse technology among small scale farmers, the study concluded that user perception, cost of technology and production risks had a direct influence on the rate of greenhouse technology adoption.

5.4 Recommendations

Based on the findings of the study, the following are the recommendations made.

Regarding objective one; the study recommends the need to increase farmers' capital and credit facilities and make these services accessible to the farmers. The government can

advance grant to farmers for specific technologies; the financial institutions such as banks can offer tailor made loans for small scale farmers with low interest rates. Insurance companies can tailor specific packages that can cushion famers against unforeseen losses.

The study also recommends the need to strengthen research and extension to provide the technical support skills required by small scale farmers, this can be done through organizing refresher courses for extension staff. Strong linkages between extension service providers and research so that extension system is up to date with latest information on technologies available in the sector.

The study further recommends the need to improve infrastructure, for instance outlet markets and roads to enable small scale farmers access the facilities with ease. Farmers can be organized into cooperatives to enable them enjoy economy of scale and group bargaining advantages.

The study finally recommends training of small scale farmers on business skills to enable them evaluate profitability of their farm enterprises.

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 greenhouse technology adoption.

The study recommends further studies on factors influencing adoption of greenhouse farming technology among smallholder farmers in other counties for generalizations.

The study also recommends research on the role of agricultural technologies in urban and Peri-urban settlements.

The study further recommends research on factors influencing smallholder farmers' decision making on the choice of technology to adopt in the face of many technologies being developed.

REFERENCES

Adesina, A. A., & Baidu, F. J. (1995). *Farmers perceptions and adoption on new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa.*

Adesina, A., & Zinnah, M. (1993). *Technology characteristics, farmers' perceptions and adoption decisions:* a Tobit model analysis in Sierra Leone .

Ahmed, S. (2004). *Factors and Constraints for Adopting New Agricultural Technology in Assam With Special Reference to Nalbari District:* An Empirical Study.

Akudungu, M. A., Guo, E., & Dadzie, S. K. (2012). *Adoption of modern agricultural production technologies by farm households in Ghana:* What factors influence their decisions? Journal of Biology, Agriculture and Healthcare 2(3): 1-13.

Awotide, B. A., Abdoulaye, T., Alene, A., & Manyong, V. M. (2015). *Impact of Access to Credit on Agricultural Productivity:* Evidence from Smallholder Cassava Farmers in Nigeria.

Bonabana-Wabbi, J. (2002). *Assessing Factors Affecting Adoption of Agricultural Technologies:* The Case of Integrated Pest Management (IPM) in Kumi District.

Diiro, G., Reardon, T., Stamoulis, K., & Pingali, P. (2013). Impact of Off-farm Income on Technology Adoption Intensity and Productivity: Evidence from Rural Maize Farmers in Uganda.

Doss, C. R. (2013). *Understanding Farm Level Technology Adoption: Lessons Learned from CIMMYT's Micro surveys in Eastern Africa*. CIMMYT Economics Working Paper 03-07, Mexico, p. 1-27.

Feder, G., Just, R. E., & Zilberman, D. (1985*). Adoption of agricultural innovations in Developing Countries: A survey.* Economic Development and Cultural Change Vol 3. No 2.

Franklin, S., Manfred, Z., & Alexander, P. *The Impact of Access to Credit on the Adoption of hybrid maize in Malawi*: An.

G, F., Just, R. E., & Zilberman, D. (1985). *Adoption of Agricultural Innovations in Developing Countries:* A Survey. Economic Development and Cultural Change

Gracious, M. D., & Abdoul, G. S. (2015). *Agricultural Technology Adoption and Nonfarm Earnings in Uganda:* A Semiparametric Analysis.

Kabede, Y., Gunjal, K., & Coffin, G. (1990). *Adoption of new technologies in Ethiopian agriculture:* the case of Teguelet-Bulga District, Shoa Province

Kholi, D. S. (1995). The Green Revolution in Punjab, India: *The Economics of Technological Change. Revised version of the paper presented at a conference on Agriculture of Punjab at the Southern Asian Institute, Columbia University, USA* .

Kinyagi, A. A. (2014). *Factors Influencing the Adoption of Agricultural Technology among Smallholder Farmers in Kakamega North Sub-County, Kenya.*

Maertens, A., & Barret, C. B. (2013). *Measuring Social Networks' Effects on Agricultural Technology Adoption.*" American Journal of Agricultural Economics 95(2): 353-359

Margaret, M., & Samwel, K. (2015). *Factors determining Adoption of New Agricultural Technology by Smallholder farmers in Developing countries*. Journal of Economics and Sustainable development .

Mignouna, B., Manyong, M., Rusike, J., Mutabazi, S., & Senkondo, M. (2011). *Determinants of Adopting Imazapyr-Resistant Maize Technology and its Impact on Household Income in Western Kenya.*

Muzari, W., W, G., & Muvhunzi, S. (2012). *The Impacts of Technology Adoption on Smallholder Agricultural Productivity in Sub-Saharan Africa*: A Review. Journal of Sustainable Development

Mwangi, M., & Kariuki, S. (2015). *Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries.* Journal of Economics and Sustainable Development 6(5): 208-216.

Nguluu, S. N., Ransom, J. K., Ariithi, C. K., & Muhammad, L. (1996). *Adoption of Improved Maize Technology in Eastern Kenya.*

Nkonya, E., Schroeder, T., & Norman, D. (1997). *Factors Affecting Adoption of Improved Maize Seed and Fertilizer in Northern Tanzania.*

Ouma, J., Mwangi, W., Verkuijl, H., & Gethi, M. (2002). *Adoption of Maize Seed and Fertilizer Technologies in Embu District, Kenya.*

Ronald, J. L., Gabriel, E., & Theodora, S. H. (2016). *Effect of Farmer Field School on Adoption of Improved Cotton Production Technologies in Eastern Uganda*. Kampala: Spring Journals.

Syed, S. H., Derek, B., & Paul, W. H. (1994). *Impacts of the training and visit extension system on farmers'. Lilongwe.*

Sunding, D., & Zilberman, D. (2001). *The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector.*

Uaiene, R. N. (2011, July 21). *Determinants of Agricultural Technology Adoption in Mozambique. Paper presented at "Dialogue on Promoting Agricultural Growth in Mozambique"* . Maputo.

Uaiene, R., Arndt, C. B., & Masters, W. (2009). *Determinants of Agricultural Technology Adoption in Mozambique.* Discussion papers No. 67E, pp. 1-31.

Wandji, D. N., Pouomogne, V., Binam, J. N., & Nouaga, R. Y. (2012). *Farmer'sPerception and Adoption of New Aquaculture Technologies in the Western Highlands of Cameroon.*

Washington, M., Warimayi, G., & Shepherd, M. (2012). *The Impacts of Technology Adoption on Smallholder Agricultural productivity in Sub-Saharan Africa*: A Review. Journal of Sustainable Development; Vol. 5, No. 8; 2012 .

APPENDIX I: TRANSMITTAL LETTER

Charles Owino Dwasi
P.O Box 2580 – 40100
Kisumu
Email: dwasi.charles@yahoo.com

Dear Sir/Madam,

REF: REQUEST FOR PARTICIPATION IN ACADEMIC STUDY

I am a postgraduate student at the University of Nairobi undertaking Masters in Project Planning and Management. I am conducting a study on ***factors influencing adoption of greenhouse farming technology among small scale farmers in Gem Sub-County, Kenya.*** You have been chosen to participate in this study by responding to the questionnaire given to you

It is hoped that this study will show gaps that are existing in regard to the study area and contribute to the body of knowledge. Please provide accurate information and return the completed questionnaire to the researcher. The information you give will be treated with confidentiality and for the purpose of this research study only.

In case of any queries or clarification, contact the researcher vied the above telephone number.

Yours Faithfully,

Charles O. Dwasi

APPENDIX II: QUESTIONNAIRE

The purpose of this questionnaire is to collect data for purely academic purposes. The study seeks to investigate the factors influencing adoption of greenhouse horticultural farming in Gem sub-county. The information you will give shall be used purposely for academic and shall be treated with confidentiality. Please complete every item as honest as possible. Tick in the box next to the right response and list down your comments in the spaces provided accordingly. You don't need to write your name.

SECTION A: General Information

1. What is your gender (Please tick one)

   Male [ ]

   Female [ ]

2. What is your age (please tick one)

   Less than 25 years [ ]

   Between 25-35 years [ ]

   Between 35-45 years [ ]

   Between 45-55 years [ ]

   Above 55 years [ ]

3. Please indicate your highest level of education (please tick one)

   Never been to school [ ]

   Primary [ ]

   Secondary [ ]

College/University [ ]

4. Are you a practicing greenhouse farmer (please tick one)

   Yes [ ]

   No [ ]

5. How do you rate cost of buying a greenhouse

   Very expensive [ ]

   Not expensive [ ]

   Not sure [ ]

6. If you had the necessary financial support, would you adopt greenhouse farming?

   Yes [ ]

   No [ ]

7. Does lack of financial capital hinder you from practicing greenhouse farming?

   Yes [ ]

   No [ ]

SECTION B: Access to Financial Capital

8. What is your level of agreement with the following statements (Please tick appropriately)

STATEMENT	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Access to loan facility					

1	Greenhouses are too expensive for smallholder farmers to afford					
2	Prices for farm inputs for greenhouse are too high for small scale farmers					
3	Cash basis of accessing greenhouse farm inputs makes it difficult for small scale farmers to afford.					
Financial Support						
1	Small scale farmers in this area have access to loans					
2	Small scale farmers in this area have access to grants					
3	Small scale farmers in this area have access to donations					
Income levels						
1	Small scale farmers have other nonfarm income					
2	Small scale farmers in this area are engaged in other gainful employment.					

SECTION C: Technical Skills

9. What is your level of agreement with the following statements (Please tick appropriately)

STATEMENT		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Access to extension support						
1	Small scale farmers have reliable extension support					

2	The cost of extension support is affordable to small scale farmers in this area					
Technical training						
1	Farmers with technical skills on greenhouse are more likely to adopt the technology.					
2	Technical training in greenhouse farming is affordable to small holder farmers in this area					
Education levels						
1	In your opinion, does level of education accelerate adoption of greenhouse farming					
2						

SECTION D: Market Availability

10. What is your level of agreement with the following statements (Please tick appropriately)

STATEMENT		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Proximity to urban centers						
1	Small scale farmers are exploited by the middlemen					
2	Smallholder farmers suffer post-harvest losses due to distance to market					

Market stability						
1	Unstable produce market discourages farmers from adopting greenhouse farming					
2	Frequent fluctuation in market prices discourages farmers from adopting greenhouse farming					
Point of sale						
1	Smallholder in this area sell their produce at the Farm gate					
2	Smallholders in this area sell their produce at wholesale market					

SECTION E: Technology Characteristics

11. What is your level of agreement with the following statements (Please tick appropriately)

STATEMENT		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
User preference						
1	Smallholder farmers prefer greenhouse farming to open field					
2	Greenhouse farming is more attractive					
Cost of technology						
2	Greenhouse farming require huge capital to start					
3	greenhouses are too expensive for small scale farmers					
Perceived Risk						

1	Greenhouse farming is so risky for small scale farmers					
2	Greenhouse farming is too complex for small scale farmers					

12. How do you rate the adoption of greenhouse technology among small holder farmers?

    High [ ]

    Average [ ]

    Low [ ]

13. If response in the question above are average/low, what do you think are the possible causes for the average/low adoption rate?

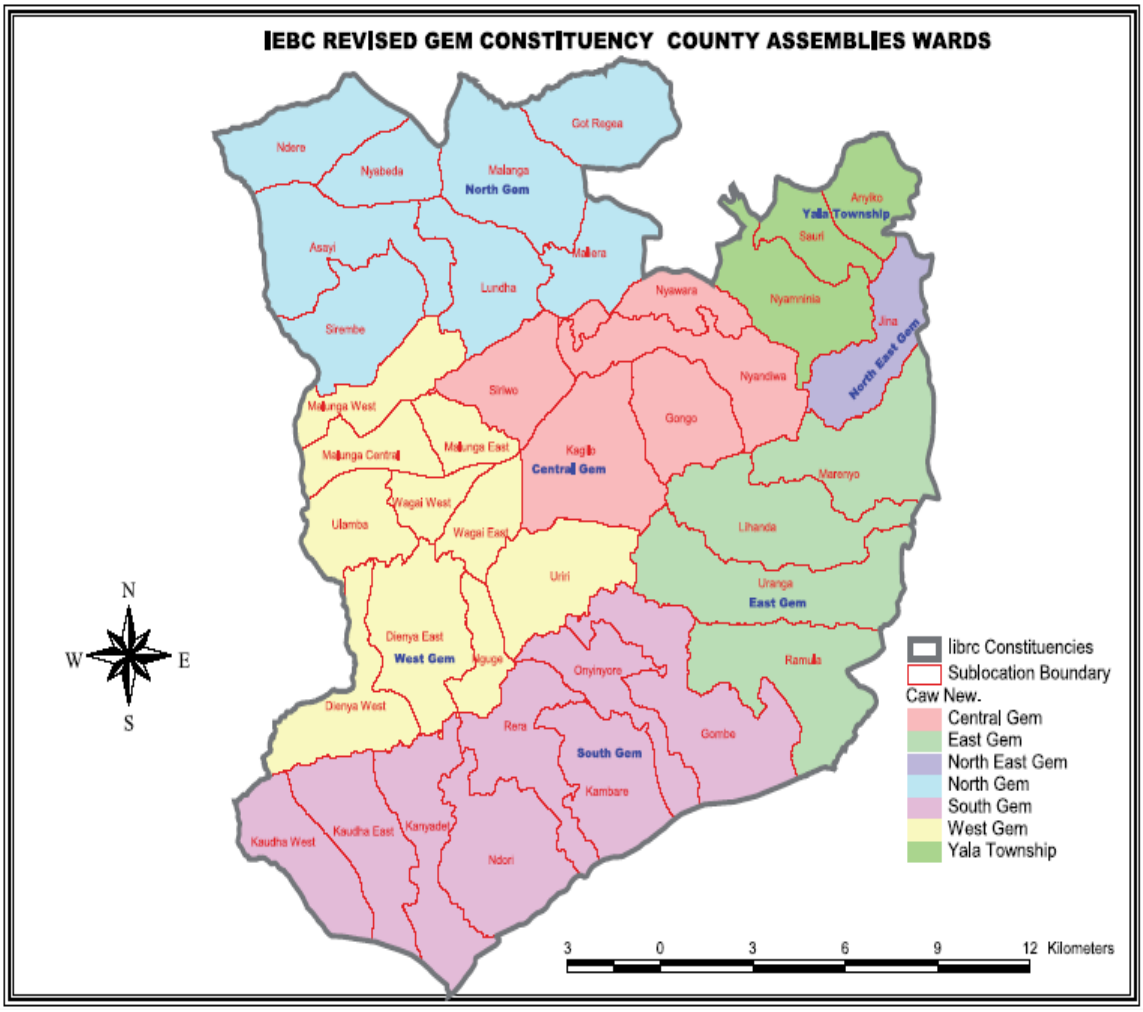
……

……

14. What do you think can be done to improve greenhouse technology adoption among small scale farmers in Gem sub-county?

……
……
……....

APPENDIX III: MAP OF GEM CONSTITUENCY SHOWING COUNTY ASSEMBLY WARDS



NB: Gem sub-county is made up of East Gem, Central Gem and Yala Township Wards.

UNIVERSITY OF NAIROBI
OPEN, DISTANCE AND e-LEARNING
SCHOOL OF OPEN DISTANCE LEARNING
KISUMU CAMPUS

The Secretary
National Council for Science and Technology
P.O Box 30623-00100
NAIROBI, KENYA

17th OCTOBER, 2017

Dear Sir/Madam,

RE: DWASI CHARLES OWINO - REG NO: L50/84816/2016

This is to inform you that **Dwasi Charles Owino** named above is a student in the University of Nairobi, Open, Distance and e-learning centre, School of Open and Distance learning, Kisumu Campus.

The purpose of this letter is to inform you that **Charles** has successfully completed his **Masters** course work and Examinations in the programme, has developed Research Proposal and submitted before the School Board of Examiners which he successfully defended and made corrections as required by the School Board of Examiners.

The research title approved by the School Board of Examiners is*: "Factors Influencing Adoption of Greenhouse Farming Technology among Small Scale Farmers in Gem Sub-County, Kenya".* The Project is part of the pre-requisite of the course and therefore, we would appreciate if the student is issued with a research permit to enable him collect data and write a report. Research project reflect integration of practice and demonstrate writing skills and publishing ability. It also demonstrates the learners' readiness to advance knowledge and practice in the world of business.

We hope to receive positive response so that the student can move to the field to collect data as soon as he gets the permit.

Yours Faithfully

CO-ORDINATOR SCHOOL OF ODeL – KISUMU CAMPUS
17 OCT 2017
P.O. Box 825 – 40100, KISUMU

Dr. Stephen Okelo, PhD
COORDINATOR ODeL
KISUMU CAMPUS

THIS IS TO CERTIFY THAT:
MR. CHARLES OWINO DWASI
of UNIVERSITY OF NAIROBI, 0-40100 KISUMU,has been permitted to conduct research in *Siaya County*

on the topic: *FACTORS INFLUENCING ADOPTION OF GREENHOUSE FARMING TECHNOLOGY AMONG SMALL SCALE HORTICULTURE FARMERS IN GEM SUB-COUNTY, KENYA*

for the period ending:
14th November,2018

.....
Applicant's Signature

Permit No : NACOSTI/P/17/36560/20047
Date Of Issue : 15th November,2017
Fee Recieved :Ksh 1000

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

ORIGINAL

OFFICIAL RECEIPT AC: 19965

Station Nairobi Date 7/11/17

RECEIVED from Charles Owino Dwasi

Shillings One Thousand Only cents Nil

on account of Research permit

Vote R43

Head

Item 1515

Cash

Cheque No. Direct deposit

USD

Kshs 1,000 = 00

AC No.

Signature of Officer receiving remittance

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: 020 400 7000,
0713 788787,0735404245
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/36560/20047**

Date: **15th November, 2017**

Charles Owino Dwasi
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Factors influencing adoption of greenhouse farming technology among small scale horticulture farmers in Gem Sub-County, Kenya".*** I am pleased to inform you that you have been authorized to undertake research in **Siaya County** for the period ending **14th November, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Siaya County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Siaya County.

The County Director of Education
Siaya County.