# FACTORS INFLUENCING ADOPTION OF GREENHOUSE TECHNOLOGY: CASE OF GATITU SUB-LOCATION IN NYERI CENTRAL DISTRICT, NYERI COUNTY

BY



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A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN PROJECT PLANNING AND MANAGEMENT OF THE UNIVERSITY OF NAIROBI

2012

## DECLARATION

I declare that this is my original work and has never been presented for the award of any degree in any other university.

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## DEDICATION

This research project is dedicated to my family: my dear husband James, my two children Catherine and Albert for their great support and encouragement throughout my research work.

## ACKNOWLEDGEMENT

I am sincerely grateful to the Almighty God for His great love, mercies, grace and provision. My sincere thanks go to Dr. Lilian Otieno-Omutoko, the resident lecturer and all the lecturers and staff of the Extra Mural Nyeri Center of the University of Nairobi for supporting me all through my Masters studies and specifically in this study.

Special thanks go to my supervisors Dr. Florence Itegi and Mr. Mburung'a for their great and unwavering support and advice. Their joint concern and sacrifice has greatly touched my heart.

I thank all my colleagues in the Masters class for their mutual support and encouragement as we journey together in pursuit of excellence. My thanks also go to Kellen Waigwa who helped me in typing this work. My sincere thanks also go to the research assistant for the effort put during data collection exercise and all the respondents for sacrificing their time and for volunteering useful information that made this study a success. To all I say: May the Almighty God bless you abundantly.

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## ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| **ASDS** | - | Agriculture Sector Development Strategy |
| **FAO** | - | Food and Agriculture Organization |
| **HCDA** | - | Kenya Horticultural Development Authority |
| **HYV** | - | High Yielding Varieties |
| **KARI** | - | Kenya Agricultural Research Institute |
| **KWFT** | - | Kenya Women Finance Trust |
| **MDGs** | - | Millennium Development Goals |
| **MOA** | - | Ministry of Agriculture |
| **NARL** | - | National Agricultural Research Laboratories |
| **WEF** | - | Women Enterprises Funds |
| **WFP** | - | World Food Programme |
| **YEF** | - | Youth Enterprises Fund |

## ABSTRACT

A household or a country that is food insecure cannot be peaceful let alone being able to achieve any meaningful economic development. One of the most effective ways of enhancing food security is through adoption of modern technologies such as greenhouse technology which increases crop productivity, food safety and also environmentally friendly. From Ministry of Agriculture Nyeri Central District only 16 farmers out 667 farmers had greenhouses in Gatitu Sub-location. The purpose of the study was to assess the factors influencing the adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County. These factors were finances, knowledge, availability of materials and gender issues. The study employed descriptive survey design whereby both Purposive and Simple Random Sampling methods were used. Purposive sampling was used to sample farmers with greenhouses because they posses more information on greenhouse technology while Simple Random Sampling was used on farmers without greenhouses since this population was homogenous. Questionnaires and observation guide were used as the data collection instruments. Statistical data was analyzed with the help of Statistical Package of Social Sciences (SPSS). For qualitative data, use of content analysis to identify patterns and theme was identified. The relationship between dependent and independent variables was analyzed using Pearson Product Moment Correlation. Data was presented using frequency distribution tables, mean, standard deviation and percentages. The key findings of this study were that majority of farmers depended on loans as a source of capital for investing in greenhouse technology although loans were expensive and mostly required collaterals as security. Access to finance seemed to be the biggest impediment to adoption of greenhouse technology and it greatly determined the level of greenhouse technology adopted. Access to greenhouse materials greatly influences adoption of greenhouse technology. Majority of farmers were using second hand materials instead of new ones because new materials were more expensive. Materials were also not available locally but available from Nairobi and Naivasha. Most greenhouses were owned by men by virtue of being majority decision makers and having more access to credit men than women. More women than men were providing labour in the greenhouses despite being minority decision makers and owners meaning that greenhouse is a male dominated activity where women are marginalized. There was low youth participation on greenhouse technology and adoption of greenhouse technology was low and at very low technology levels. The study recommendations: Ministry of Finance should collaborate with the financial institutions to make credit more accessible and affordable to the farmers, Ministry of Agriculture in collaboration with private agricultural extension providers should organize trainings on greenhouse technology and run training programmes through the media to enhance coverage and also make greenhouse materials more available and affordable to the farmers, Ministries of youth and Gender should come up with strategies of encouraging youth and women respectively to adopt greenhouse technology as a means of enhancing employment creation and household food security. The generalized findings of the study would be useful to the government in formulating regulations and policies concerning promotion of adoption of greenhouse technology for enhancement of food security in the country and also as a means of enhancing agricultural development in line with Vision 2030 development plan and millennium development goals. On the other hand, the study would be useful in trying to bridge the knowledge gap on the factors influencing adoption of greenhouse technology. The findings of the study would also help the farmers with greenhouses to deal with some of the factors influencing adoption of this technology.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

The world is facing a potential crisis in terms of food security. Around a billion people globally do not have adequate food to meet their basic nutritional needs (Mark and Sarah, 2003). Food and Agriculture Organization (FAO) has predicted that demand for food will grow by 50% by 2030 and 70% by 2050. Therefore the challenge is to meet the rising demand for food in ways that are environmentally, socially and economically acceptable (Mark and Sarah, 2003).

Developed countries in the world have been able to achieve food security as a result of fast adoption of modern technologies such as greenhouse among other factors. Worldwide, the main green house vegetable production areas include Spain, Netherlands, Mexico, Canada and the United States (Columbia, 2003).

Food insecurity is almost synonymous with most of the African countries due to factors such as frequent droughts and agricultural dependency on the climate and environment (rain fed agriculture), overall decline in farm input investment including fertilizer, seeds and technology adoption, poor policies among other factors. Food security on the continent has worsened since 1970 and the proportion of the malnourished population has remained within the 33 to 35 percent range in Sub-Saharan Africa (Angela, 2006).

About a third of Kenya's population estimated at 40 millions are food and nutrition insecure. Food and nutrition insecurity is closely linked to poverty and low agricultural production. Currently over 10 million people in Kenya suffer from chronic food insecurity and poor nutrition, and between two and four million people require emergency food assistance at any given time. Nearly 30% of Kenya's children are classified as undernourished and

Strategy (ASDS) notes that some of the factors contributing to poor returns include low adoption of modern technologies such as greenhouse, lack of access to credit and gender inequalities that constrain resource access (GOK, 2011).

Gatitu Sub-Location and Nyeri Central District at large are also striving to achieve food security; about 48% of the population in the district is food insecure hence has constantly been getting relief food to mitigate against hunger for the most vulnerable households (MOA, 2011). Despite the fact that there has been promotion of various modern technologies such as greenhouse technology to enhance food security in Gatitu Sub-Location, the adoption has been quite low and currently only 16 farmers out of 667 farmers have greenhouses in this Sub-Location. Most of these greenhouses are of low technology where the farmer uses wooden poles and second hand polythene paper as the covering material (MOA, 2011).

A greenhouse requires higher capital to establish, run and maintain to serve its intended purpose efficiently (Clifton, 2004). Paul (2001) suggested that before an individual contemplates on establishing a greenhouse, there is need to have adequate knowledge. There is also need to source for the right materials for a particular greenhouse (MOA, 2011). The general success in small scale industry in Africa and third world countries is more reliant on male gender than female gender, the notion that specific operations and technologies like greenhouse are meant for men who are the minority have by far weakened the fight against hunger (Borlaug 2000).

This study sought to assess the factors influencing adoption of green house technology in Gatitu Sub-location in Nyeri Central District, Nyeri County.

## 1.2 Statement of the Problem

The changing climatic conditions have brought about very unpredictable rainfall patterns and frustrated many farmers who depend on rain fed crop production (Kamau &Baumgartner, 2009). Under optimal conditions, growing vegetables and fruits in a greenhouse can give the farmers up to ten times what they would get if they did the same in an open rain fed field. Due to severe food shortage mainly because of prolonged drought, greenhouse vegetables have become a solution for rural communities in Kenya (Kamau &Baumgartner, 2009).

Ashraf (2008) observed that the major obstacle towards the success of the greenhouse technology is finance. A greenhouse requires higher capital to establish, run and maintain for it to serve its intended purpose efficiently (Clifton, 2004). Paul (2001) suggests that before an individual contemplates on establishing a greenhouse, there is need to have adequate knowledge about greenhouse technology.

There is also need to source for the right materials for a particular greenhouse but these materials are not locally available and are only sourced from major towns such as Nairobi (MOA,2011).In Africa and other third world countries where success of small scale industry is more reliant on male gender than female gender coupled with the notion that specific operations and technologies like greenhouse are meant for men who are the minority have by far weakened the fight against hunger (Borlaug 2000).

In Gatitu Sub-location of Nyeri Central District only 16 farmers out of a total of 667 farmers have adopted greenhouse technology (MOA, 2011) which an indication of low adoption. It is for this reason that this study sought to assess the factors influencing adoption of greenhouse technology in Gatitu Sub-location in Nyeri Central District, Nyeri County.

### 1.3 Purpose of the Study

The main focus of the study was to assess the factors influencing the adoption of green house technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County.

### 1.4 Objectives of the Study

The study aimed at achieving the following objectives:

1. To assess the current greenhouse farming practices in Gatitu Sub-Location in Nyeri Central District, Nyeri County.
2. To assess how financing of greenhouse influences adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County.
3. To establish the extent to which knowledge on greenhouse influence the adoption of greenhouse technology Gatitu Sub-Location in Nyeri Central District, Nyeri County.
4. To determine the extent to which availability of greenhouse materials influence the adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County.
5. To establish the extent to which gender issues influence the adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County.

### 1.5 Research Questions

This study aimed at answering the following research questions:

1. How does financing of greenhouse influence adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County?
2. To what extent does the knowledge on greenhouse influences adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County?

3. How does availability of greenhouse materials affect adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County?
4. To what extent do the gender issues affect adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County?

## 1.6 Hypotheses of the Study

The hypotheses of the study were:

1. Ho: Access of credit from financial institutions does not significantly influence the level of greenhouse technology adopted

   HI: Access of credit from financial institutions does significantly influence the level of greenhouse technology adopted.
2. Ho: Access to knowledge on greenhouse does not significantly influence the level of greenhouse technology adop

   HI: Access to knowledge on greenhouse does significantly influence the level of greenhouse technology adopted.

## 1.7 Significance of the study

The generalized findings of the study will be useful to the government and particularly the counties in formulating appropriate regulations and policies concerning promotion and adoption of green house technology as a means of enhancing economic development and food security in the country in line with Vision 2030 development plan and millennium development goals.

On the other hand, the study will be useful in trying to bridge the knowledge gap on the factors influencing adoption of green house technology.

The findings of the study will also help the farmers with greenhouses to overcome some of the challenges that affect them and also encourage more farmers to adopt this technology. The study will also be useful in provision of more empirical data.

### 1.8 Limitation of the Study

The study took into account that time and financial constraint may affect the geographical coverage of the study. Since it was not be possible to study the whole population, the study was limited to a sample of farmers in Gatitu Sub-Location in Nyeri Central District, Nyeri County.

### 1.9 Delimitation of the Study

The study was limited to Gatitu Sub-Location in Nyeri Central District, Nyeri County. Descriptive survey design was used with the questionnaire and observation guide as the data collection toosl and the data was analyzed using descriptive statistics with the help of electronic spreadsheet programme of statistical package of social sciences, (SPSS). Target population was the 667 farmers from Gatitu Sub-Location from which purposive and simple random selection sampling methods were used to get a sample of 81 farmers who were the respondents in the study.

### 1.10 Assumptions of the Study

The studies assumptions were that the respondents would provide factual and valid information so as to get valid data. It is also assumed that the sample was unbiased representative of the population and that the respondents would avail the information required within the stipulated time.

### 1.11 Definition of Significant Terms

**Greenhouse technology:** This is a technology which involves construction of a permanent or temporary structure covered with transparent material that transmits natural sunlight and provides modified environmental conditions for plant growth. The structure is sufficiently high to permit a person to work from within. The term "green" refers to the green scenery or crops in the structure rather than the material of the structure.

**Food security:** This is a situation that exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active healthy life.

**Adoption:** This refers to the uptake of the technology.

**Greenhouse financing:** This encompasses general acquisition of money required to start and/or run a greenhouse.

**Greenhouse knowledge:** In this study greenhouse knowledge refers to the information that the farmers need to be able to adopt greenhouse technology.

**Gender:** This refers roles played by men, women and youth in the adoption and management of greenhouse technology projects.

**Availability of greenhouse material:** This refers to the extent to which right material for constructions of greenhouses are accessible to farmers.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

In this chapter, theoretical literature mainly from text books, journals, magazines, press releases, internet and other literally materials were reviewed highly with an effort of achieving the research objectives and answering the research questions that guided the study. This chapter therefore highlighted issues on greenhouse technology, food security, financing of greenhouse technology, knowledge on greenhouse technology, availability of greenhouse materials, gender issues in greenhouse technology and the current greenhouse farming practices. A Conceptual framework was also used to bring out the relationship between the independent and the dependent variables for the study.

## 2.2 Greenhouse Technology

Technology is a body of techniques, methods, processes and designs used to achieve some intended purpose. It is the tool as well as the knowhow to use the tool, (Dabadi, 2003). Greenhouse is a technology not only for enhancement of food security but for overall economic growth of any nation. A greenhouse is defined as a structure covered with transparent material that transmits natural sunlight for plant growth. It is a permanent or temporary structure that provides a modified environmental conditions and effectively using solar energy for plant growth. It is sufficiently high to permit a person to work from within and it mainly refers to the green scenery (crops) in the structure rather than the material of the structure (Gao-Qiong, 2005).

A greenhouse can also be defined as a framed or an inflated structure covered with a transparent or translucent material in which crops could be grown under the conditions of at least partially controlled environment and which is large enough to allow persons to work within it to carry out cultural operations, (Narasaih 2007). Greenhouse enables the farmer to control the growth conditions thereby protecting the crops against the vagaries of weather. It also protects against pest pests and diseases (Njagi, 2011). An additional advantage of the technology is that it reduces emissions of greenhouse gases (GHGs) by agrochemicals to the atmosphere thus reducing effects of global warming and climate change (Njagi, 2011).

Greenhouse technology has other numerous advantages such as throughout the year four to five crops can be grown in a greenhouse due to the availability of required plant environmental conditions, the productivity of the crop is increased considerably, superior quality produce can be obtained as they are grown under suitably controlled environment, gadgets for efficient use of various inputs like water, fertilizers, seeds and plant protection chemicals can be well maintained in a greenhouse (Wikipedia,2012). A greenhouse as opposed to open land has many advantages some of which are: Effective control of pests and diseases is much more effective than in open land as the growing area is enclosed, percentage of germination of seeds is higher, agricultural and horticultural crop production schedules can be planned effectively to take advantage of the market needs. Different types of growing medium like peat mass, vermiculate, rice hulls and compost that are used in intensive agriculture can be effectively utilized in the greenhouse, export quality produce meeting international standards can be produced in a greenhouse, when the crops are not grown drying and related operations of the harvested produce can be taken up utilizing the entrapped heat.

It is suitable for automation of irrigation, application of other inputs, and environmental controls by using computers and artificial intelligence techniques and self-employment for educated youth on farm can be increased (Wikipedia, 2012).

A greenhouse may be of high or low technology depending on materials used for construction, level and number of equipment used to grow the crops. Larger green houses have sophisticated, computerized climate control systems continuously monitoring and regulating temperatures, light, humidity, irrigation and nutrient levels to optimize plant growth (Bhat, 2002).

Worldwide, the main green house vegetable production areas include Spain, Netherlands, Mexico, Canada and the United States. Production in Mexico and Spain consists of a variety of production systems ranging from low to high technology green houses. Production in the Netherlands, Canada and the United States consists primarily of high technology green houses with significantly higher yields (Columbia, 2003).

In Kenya there are two types of greenhouses that are practiced by the small scale farmers. The first type is tunnels which cover ¼ acre or less and are built with fabricated wood and polythene papers and last for two years. The other type is the larger greenhouses are metallic structures with polythene and last up to 10 years (Njagi, 2011).

The changing climatic conditions have brought very unpredictable rainfall patterns and frustrated many farmers. Consequently green house technology may provide an alternative method of food production and generation of farm incomes Due to severe food shortage mainly because of prolonged drought, green house vegetables have become a solution for rural communities (Kamau &Baumgartner, 2009).

Greenhouse technology should be embraced as a way of minimizing food insecurity in the country as it plays a key role in shifting from rain-fed farming to greenhouse for growing crops under controlled environment (Njagi, 2011).

In Kenya, according to Ministry of Agriculture Strategic Plan (2009) there is low adoption of modern technologies such as greenhouse. In Gatitu Sub-Location in Nyeri Central District, Nyeri County only 16 farmers out of 650 farmers have greenhouses (MOA, 2011).

**2.3 Food Security and Greenhouse Technology**

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active healthy life (FAO). Food security has three aspects; food availability, food access and food adequacy. Food availability has to do with the supply of food. This should be sufficient in quantity and quality and also provide variety.

Food access addresses the demand for the food. It is influenced by economic factors, physical infrastructure and consumer preferences (Angela, 2006). Food availability, though elemental in ensuring food security, does not guarantee it. For households and individuals within them to be food secure, food at their access must be adequate not only in quantity but also in quality. It should ensure an adequate consistent and dependable supply of energy and nutrients through sources that are affordable and socio-culturally acceptable to them at all times (Angela, 2006).

The world is facing a potential crisis in terms of food security; around a billion of people globally do not have adequate food to meet their basic nutritional needs.

The world faces a potentially even greater crisis in food security as the global population is expected to grow from about 6.9 billion (late 2010) to more than a billion by 2050 (Mark and

Sarah, 2003). FAO has also predicted that demand for food will grow by 50% by 2030 and 70% by 2050.

Therefore, the global challenge is to provide the world's population with a sustainable, secure supply of good quality food that must be safe, nutritious and affordable, and available to all, with improved equity of distribution, and reflect local social and cultural needs using the same or less land and fewer inputs, produce less waste and have a lower environmental impact (UK, 2003).

The other the challenge is to meet the rising demand for food in ways that are environmentally, socially and economically sustainable and in the face of evolving world-wide markets and distribution mechanisms and global climate and demographic changes. (Mark and Sarah, 2003)

Progress in ensuring a sustainable and equitable food supply chain will be determined by how coherently these long term challenges are tackled which will also determine progress in reducing global poverty and achieving the Millennium Development Goals (MDGs) (Beddington, 2009).

While the rest of the world has made significant progress towards poverty alleviation and food security, Africa, in particular Sub - Saharan Africa continues to lag behind. Projections show that there will be an increase in this tendency unless preventive measures are taken. Many factors have contributed to this tendency including frequent drought and agricultural dependency on the climate and environment among other factors (Angela, 2006).

In most African countries, agriculture is the major source of food and income. Despite the potential to increase agricultural production, the performance has been generally poor. The AU Commission's food security report (2005) estimated that African production has to increase by at

least four to six percent per annum on a sustained basis to meet the food needs of the African population that is expected to increase from about 0.90 billion in 2005 to 1.26 billion in the year 2020.

Food security on the continent has worsened since 1970 and the proportion of the malnourished population has remained within the 33 to 35 percent range in Sub-Saharan Africa. The prevalence of malnutrition within the continent varies by region. It is lowest in Northern Africa (4 percent) and highest in Central Africa (40 percent).

Over 70% of the food insecure population in Africa lives in the rural areas. Ironically, small holder farmers, the producer of over 90% of the continent food supply, make up majority (50%) of this population. Hence one of the key issues lies in increasing the agricultural profitability of the small holder farmers. 95% of the food in Sub-Saharan Africa is grown under rain fed agriculture. Hence food production is vulnerable to adverse weather conditions. There is also an overall decline in farm input investment including fertilizer, seeds and technology adoption. Poor policies have greatly affected the food security in Africa (Angela, 2006).

Kenya like other developing countries is faced with hunger and poverty and these problems are getting worse by the day. A number of factors contribute to this situation but poor agriculture performance lies at the heart of the problem (Kang'ethe, 2004). Although agriculture is critical to the Kenyan economy, levels of production and productivity are very low and the vast potential of the sector has scarcely been tapped.

Some of the factors contributing to poor returns include low application of modern technologies as nearly per cent of production is from smallholder with less than 2 ha, lack of access to credit and gender inequalities that constrain resource access (GOK,2011).

The 2007 Economic Review of Agriculture indicates that 51% of the Kenyan population lack access to adequate food. Food security is closely linked to poverty which is estimated at 46% nationally. Achieving food security is a key challenge to the government of Kenya. A range of factors affect food security such as climatic, technological among others (Bahemuke, 2008).

Agriculture Sector Development Strategy (ASDS) notes that, although agriculture is critical to the Kenyan economy, levels of production and productivity are very low and the vast potential of the sector has scarcely been tapped. Some of the factors contributing to poor returns include low adoption of modern technologies, lack of access to credit and gender inequalities that constrain resource access (GOK, 2011).

About a third of Kenya's population estimated at 40 millions are food and nutrition insecure. Food and nutrition insecurity is closely linked to poverty and low agricultural production .Currently over 10 million people in Kenya suffer from chronic food insecurity and poor nutrition, and between two and four million people require emergency food assistance at any given time. Nearly 30% of Kenya's children are classified as undernourished and micronutrient deficiencies are widespread (GOK, 2008). It is the policy of the government that all Kenyans throughout their life-cycle enjoy at all times safe food in sufficient quantities and quality to satisfy their nutritional needs for optimal health. Investing in agriculture is one of the most high–impact, cost-effective strategies available for reducing poverty and improving livelihoods.

There is substantial evidence that gender-based constraints restrict the productivity of female Kenyan small holders and contract farmers. This is important because women form the majority of the active farming population. Many young men and women also face gender-based constraints. There is no doubt that the on-going climate change affects the agricultural

production both in high-potential and dry areas. These effects need to be considered in the strategic efforts for improving food security through adoption of modern technologies and the planning of production at farm level (Kang'ethe, 2004).

ASDS notes low absorption of modern technology that is, low application of science and technology in agriculture as one of the constraints in production (GOK, 2011). Kenya imported about 725 million dollars in agricultural products during 2009, up from about 525 million dollars in 2007 in an attempt to mitigate the current food crisis.

Gatitu Sub-Location and Nyeri Central District at large is also striving to achieve food security, about 48% of the population is food insecure hence has constantly been getting relief food to mitigate against hunger for the most vulnerable households. However only 16 farmers out of 667 have greenhouses in the Sub-Location (MOA, 2011).

## 2.4 Financing of Greenhouse Farming

There is need to fully support and establish greenhouses if the Government is fully committed towards securing food security. The major obstacle towards the success of the greenhouse technology is finance. He points out that there are various types of greenhouses, like the Even span type greenhouse, Ridge and Furrow type greenhouse, Saw tooth type greenhouse, Quonset greenhouse among others (Ashraf, 2008). In Kenya today, various types of greenhouses come with valid costs which in Kenya today very few people can afford since majority are low and medium class earners, KARI (2008).

According to the Kenya Agricultural Research institute (KARI) report on food security, it is pointed out that lack of enough funds to support agricultural technologies like greenhouse has led to increased food insecurity. In Kenya, KARI has established a miniaturized greenhouse that yields 15kg-20kg in the first harvest and 60kg at full cycle (KARI, 2008).

These and other crops could play a key role in eradicating hunger in Gatitu Sub-Location in Nyeri central district, Nyeri County but few farmers or individuals afford to start.

Tall (2011), indicated that starting a greenhouse today is more expensive. He observed that there exists the glass greenhouse, Plastic film greenhouse and Rigid Panel greenhouses. According to KARI (2008), a greenhouse made from local materials like wood, net and polythene measuring 6m by 15m costs Kshs 46,000 and lasts for 4-5 yrs. Kamau & Baumgartner (2009), indicates that a rather good value kit is produced by Armiran Kenya Ltd, a company based in Nairobi. This kit covers a 1/8 of an acre and goes for about Kshs. 198,000 which also includes technical assistance, labour, seeds and organic inputs.

Dan (2011) also observed that the more expensive and long lasting Small-scale Metallic Greenhouse Mirrors measuring 8m by 15m costs Kshs 140,000. According to the MOA (2011) this amount is just but far above the income levels of the majority of farmers in Gatitu Sub-Location, Nyeri District, Nyeri County who cannot raise this amount thus making financing of greenhouse farming not only expensive but also very demanding while cases of food insecurity and hunger in general thrives day by day in this Sub-Location. Bhupendra, (2007) indicated that the inputs required in maintenance of greenhouse are more expensive. The seeds like tomatoes, capsicum, cucumber, strawberry, Melons, Lettuce; among others types are very expensive. The points out that the use of insecticides like fungicides, insecticides ,the heating systems, watering systems, labour among others major inputs requires substantial funding.

According to the Ministry of Agriculture Nyeri Central District (2011), some farmers have been forced to abandon greenhouse projects as a result of lack of funds. This has dealt a major blow towards the fight against food insecurity in Gatitu Sub-Location and other areas in the District.

The Government of Kenya (2006) through Women Enterprises Funds (WEF) ,Youth Enterprises Fund (YEF) and Equity bank in collaboration with Armillan Kenya have tried to support groups to start the greenhouse projects in Nyeri Central District and other parts of the country as an alternative of fight against hunger but these funds are not sufficient for all the farmers (MOA,2011). Borlaug (2000) noted that greenhouse vegetables like tomatoes have twenty one self–life days as compared to fourteen days of tomatoes grown in the open. The quality is great and a Kilo goes for forty shillings.

Gatitu Sub-Location in Nyeri Central District could be in a very good position to enhance food security through greenhouses but one of the major obstacles is financing of these greenhouses (MOA, 2011).

**2.5 Knowledge on Greenhouse Technology**

According to Thompson (2010), a greenhouse technology project requires total commitment and maximum care for there to be effectiveness and efficiency of each plant to produce maximum yield. Greenhouses in Kenya have been mostly affected by farmers lacking enough knowledge on the fundamental process operations, procedures required in a greenhouse. A study by Paul (2001) suggested that before an individual contemplates on establishing a greenhouse, there is need to have adequate knowledge. The implementation of the greenhouse technology goes hand in hand with training; hence Ministry of Agriculture in collaboration with other stakeholders such as Armillan Kenya Limited are promoting and educating farmers in Gatitu Sub-Location in Nyeri Central District and other Districts in the Country on greenhouse but their services have been inadequate due to limited number of employees in both public and private sectors (GOK, 2009).

Majority of farmers willing to start up greenhouses are forced to source for external technical assistance which is more costly and this de-motivates their efforts. Lakshmi (2004) observed that majority of greenhouses fail to succeed even after establishment due to the limited knowledge by farmers. These directly play a key role in weakening fight against food insecurity. Research indicates that a fair proportion of Kenyans is illiterate and lack numeracy skills. However, there is higher use of literacy in the urban areas than in the rural areas and that men use their literacy skills more than women (Carron, Mwiria, and Righa, 1989).

In Gatitu Sub-Location in Nyeri Central District, knowledge on greenhouse operations like the general establishment, controlling cooling and heating systems, application of chemicals, watering schedules among other key areas have led to collapse of majority of them (MOA,2011). According to Vepa (2000) every operation and process in a greenhouse is fundamental. The use of growing mediums like peat mass, vermiculate, rice hill and compost requires great attention. For there to be maximum yields especially from High Yielding Varieties (HYV) most care and operations have to be undertaken. Farmers in Gatitu Sub-Location in Nyeri Central District find it hard to engage in these technological projects due to lack of knowledge.

According to National Agricultural Research Laboratories (NARL), there is need to hold rural based meetings and seminars aimed at educating farmers and individuals on the advantages of establishing greenhouses and their impact on food security in the country (KARI,2008).

Anuradha (2006) observed that greenhouse projects are Eco-friendly and thus there is desire to educate farmers on the need and general advantages of member.

The World Food Programme (WFP) report on food security in Africa pointed at that lack of proper knowledge on modern farming methods and techniques costs African Countries billions of shillings on food Aid.

The Kenyan government through the Ministry of Agriculture strategic plan (2009) has also highlighted poor information on techniques and modern methods of farming like greenhouse as the hindrance towards enhancing food security in Gatitu Sub-Location in Nyeri Central District and other parts in the country. According to Prajad (2010) the day to day success of greenhouses calls for great ideas both technologically and technically. The uses of technology in Asia especially in India on greenhouse have enabled the country to conquer food insecurity. According to KARI report (2008) on greenhouse technology, right from the beginning most farmers and individuals do make a mistake in general planning of their structures. Greenhouse should be built parallel to wind direction to avoid damage to crops on the outside, the use of nets, polythene, mirrors should be used to avoid pests and birds at large. In Gatitu Sub-Location in Nyeri Central District, majority of individuals have interest on greenhouse but the major challenges is technique for the construction of the structure, incorporation of technology like the installation of temperature sensors that is thermostat and thermistors. These inadequacies have led to massive loss of yields as sometimes the prevailing temperature does not favor the growing fruits and vegetables (KARI, 2008).

According to Taft (2011), the greenhouse management right from the start in twentieth century to date, have incorporated technology such that the manual labour required is minimal thus saving on operating costs. In Kenya today few individuals have been able or are capable of introducing fully computerized systems like cooling and heating systems, watering systems, fertilizers application, and chemical application among other vital procedures in the greenhouse. The over reliance on manual labour in the running of greenhouses in Gatitu Sub-Location in Nyeri Central District has not hindered to fully realization of harvest and profits (MOA ,2011).

There is great need to automate major greenhouse operations like irrigation, applications of other inputs, environmental control using computers and the use of artificial intelligence techniques temperature sensors among other key operations but lack of knowledge among the farmers in the developing world has really affected fuel realization of benefits from greenhouses (Bhat (2002). In Gatitu Sub-Location in Nyeri Central District, majority of individuals with greenhouses do not have automation or general technology application in their greenhouses. The reliance on manual labour have led to inaccuracies, human errors among other key mistakes that could be avoided is only there was use of appropriate technology in their operations. Majority of individuals are forced to seek assistance technically on the use of these advanced technology which might not be adequately available in Gatitu Sub-Location in Nyeri Central District (MOA, 2011). Anarudha (2006) indicated that the use of technology like bottom heating using steam pipes that are length wise the beds during dull weather have proofed effective. In the propagating house the temperature should be maintained at 580c – 600 c and at 100c bottom heat for there to be maximum success.

In Nyeri Central District, farmers with greenhouses rely more on manual operations in controlling environmental conditions in the greenhouse which is not effective and efficient thus not realizing maximum yield. Rash (2008) indicated that the recent environmental changes have prompted massive changes in farming techniques and adoption of new methods like greenhouse technology. The general understanding of these modern farming techniques is another nightmare that has led to loss in millions of dollars and increase in food insecurity especially in Third World Countries like Kenya.

The Ministry of Agriculture annual report (2011) affirms that unless deliberate efforts are applied in enlightening farmers and individuals on modern farming techniques like greenhouse adoption will remain low in Gatitu Sub-Location in Nyeri District.

## 2.6 Availability of Materials for Greenhouse

A greenhouse requires higher capital to establish, run and maintain for it to serve its intended purpose efficiently, Clifton (2004). There is also need to source for the right materials for particular greenhouse .In Gatitu Sub-Location in Nyeri Central District the major hindrance towards the success of greenhouse projects is the lack of appropriate materials. According to the Ministry of Agriculture Nyeri Central annual report (2011) on adoption of greenhouse technology, lack of materials for the same was highlighted as a major problem. According to sigh (2009), greenhouse materials availability is the starting point of a successful venture. In Kenya majority of persons resolve the problems of lack of raw materials by using available ones like low quality polythene papers, nets, irrigation systems, Loam soils among other obstacles. This contributes to poor yields from greenhouses that directly lead to food insecurity.

Through the establishment of KARI miniaturized greenhouse the government aimed at making it easier for farmers to acquire raw materials that would be pivotal in increasing the overall output of the greenhouses.

Bhat (2002) indicated that usage of raw materials like heating systems, temperature sensors, chemicals among others have been minimal due to the all time competition in the industry. In Gatitu Sub-Location in Nyeri Central District , farmers are sometimes forced to source for the raw materials from as far as Nairobi and Naivasha which is time consuming and costly which leads to other persons willing to adopt the greenhouse technology to abandon their aims due to fear of making a loss (MOA,2011).

According to Taft (2011), every raw material in a greenhouse is a fundamental success tool and thus there is need to be well organized financially and technically. The Kenya government through Kenya rain water Association and Kari have been supporting farmers who approach them with raw materials like water reservoirs, pipes seeds among other key raw-materials. The move is aimed at spearheading the success in the adoption and running of the greenhouses and eventual enhancement of food security in Gatitu Sub-Location in Nyeri Central District and Kenya at large.

Anuradha (2011) indicated that North America relies on tomatoes from greenhouse projects and they account for 30% of all the tomatoes consumed in the United States. Government supports fully its farmers and individuals through supplying them with quality materials for greenhouse technology projects. This explains why developed countries have effectively and efficiently enhanced food security to a point of donating food to the developing countries.

Arun (2011), indicated that for there to be notable maximum yields from sweet bell peppers that produces 23kg/m2, Bravo tomatoes, Grafted tomatoes among others vegetables and fruits, there is great need to have required materials.

These materials range from electricity, chemicals, labour, growing media, water, cooling and heating systems to name but a few of the fundamental inputs required. These accounts for reasons as to why farmers and individual persons who are interested in greenhouse projects in Gatitu Sub-Location in Nyeri Central District have failed to succeed in the venture. As much as the greenhouses are profitable, the inputs are not easily accessible and their costs are up and this is a major blow towards adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District (MOA, 2011).

## 2.7 Gender issues on Greenhouse technology

Borlaug (2000) indicates that, for there to be to end of world hunger and the general success in food security ,women should be encouraged to venture in agricultural projects like greenhouses so as to increase the maximum output annually however the general success in small scale industry in Africa and third world countries is more reliant on male gender than female gender, the notion that specific operations and technologies like greenhouse are meant for men who are the minority have by far weakened the fight against hunger.

In Gatitu Sub-Location in Nyeri Central District, majority of the greenhouse are owned by men and run by men thus neglecting women (MOA, 2011). The Kenyan Government (2006) through the Ministry of Gender, women and children has come up with great ideas of supporting women through Women Enterprise Fund who are the majority to take up agricultural projects like greenhouses so as to eradicate poverty and enhance food security in all parts of the country. Paul (2007) observed that women and girls have been underestimated especially in the developing world to be incompetent in agricultural technologies as they are viewed as men's business. The various process and operations in greenhouse projects like fumigation, drip irrigation, the use of hot water technology, use of computers and artificial intelligent techniques have been viewed as more technical for women. The Kenya women finance trust (KWFT) in Nyeri Central District have carried intensive campaign to encourage women to venture in farming into farming projects like greenhouse projects so as to be self sufficient and successful. Women have also looked at the greenhouse technology and other farming technologies as men's business for a long time. These statistics have shown the little number of men in the greenhouse business is not sufficient to enhance food security in Gatitu Sub-Location Nyeri Central District (MOA, 2011).

The general success in small scale industry in Africa and third world countries is more reliant on male gender than female gender ,the notion that specific operations and projects like greenhouse are meant for men who are the minority have by far weakened the fight against hunger.

According to Vepa (2000) majority of women have ventured in small scale business that are not technical but after the long run they are no profitable as compared to agricultural projects, in Nyeri Central District majority of women have ventured in general marketing of agricultural products like tomatoes, cabbages, radishes, lettuce, capsicum and cucumber that find their way to the market from the greenhouses. According to the Kenya Government, if women in Nyeri Central District and other parts of the country fully embraced technologies such as greenhouse as an alternative business venture there would be enhancement of food security annually. However the issue of gender parity has been a major blow towards the adoption of greenhouse technology in Gatitu Sub-Location, in Nyeri Central District (MOA, 2011).

## 2.8 Conceptual Framework

In this study adoption of the greenhouse technology was the dependent variable while finance, knowledge availability of materials, gender issues were independent variables.

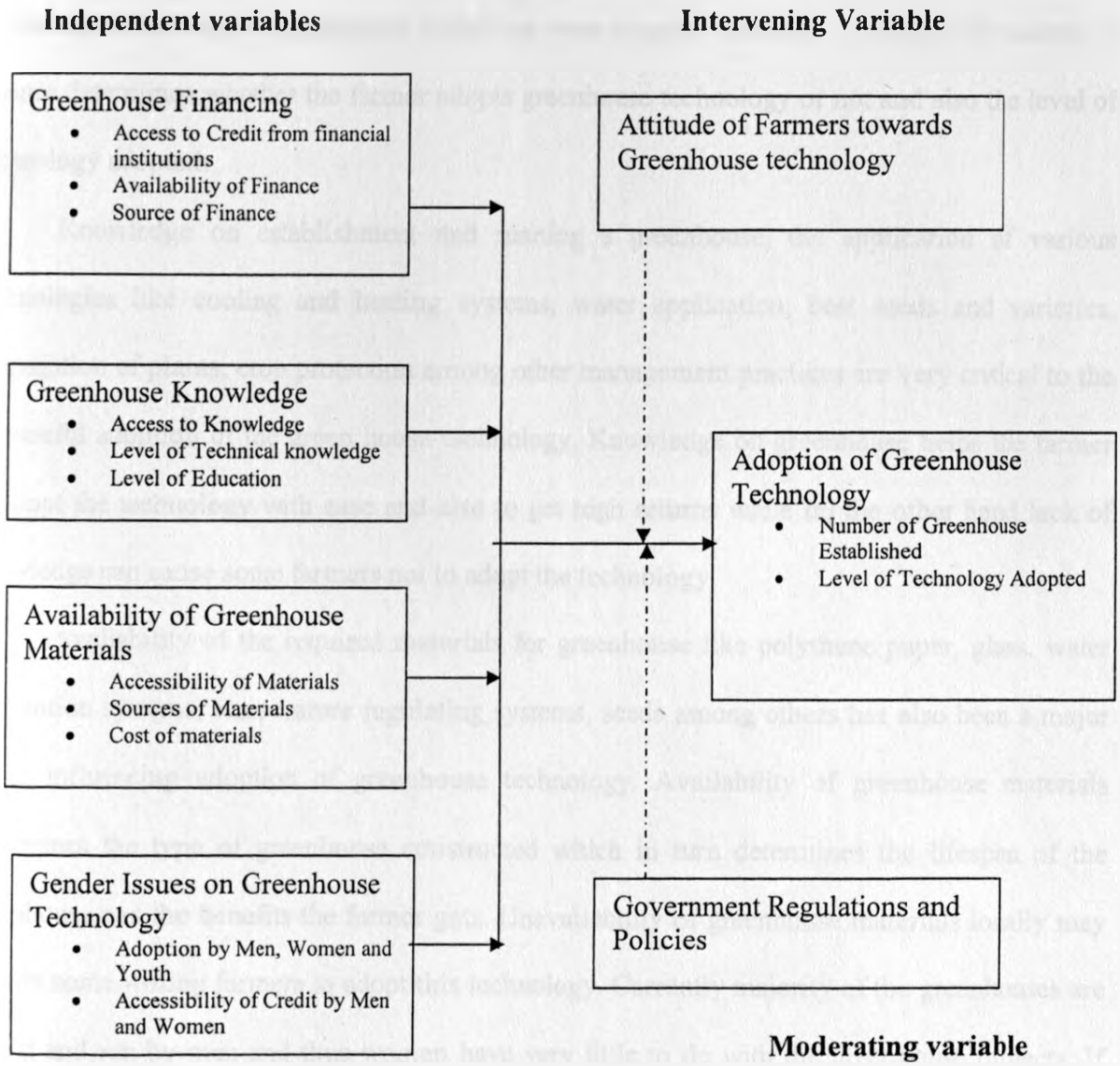


**Figure 1: Conceptual Framework**

In this study, adoption of greenhouse technology was the dependent variable while financing greenhouse technology, knowledge on Greenhouse technology, availability of materials, and gender issues on greenhouse technology were the independent variables.

Literature reviewed earlier in this chapter, showed that the amount of finances required to start up a greenhouse ranges from fifty thousand to more than half a million Kenya Shillings depending on the type of greenhouse which has been a major hindrance. Consequently access to finance determines whether the farmer adopts greenhouse technology or not and also the level of technology adopted.

Knowledge on establishment and running a greenhouse, the application of various technologies like cooling and heating systems, water application, best seeds and varieties, propagation of plants, crop protection among other management practices are very critical to the successful adoption of the green house technology. Knowledge on greenhouse helps the farmer to adopt the technology with ease and also to get high returns while on the other hand lack of knowledge can cause some farmers not to adopt the technology.

Availability of the required materials for greenhouse like polythene paper, glass, water application systems, temperature regulating systems, seeds among others has also been a major factor influencing adoption of greenhouse technology. Availability of greenhouse materials determines the type of greenhouse constructed which in turn determines the lifespan of the greenhouse and the benefits the farmer gets. Unavailability of greenhouse materials locally may hinders some willing farmers to adopt this technology. Currently majority of the greenhouses are owned and run by men and thus women have very little to do with the greenhouse projects. If only greenhouse technology would be equally adopted by both men and women, food security can be greatly enhanced at household, national and even globally.

Government policies are supposed to create favourable conditions to enable the farmers to easily adopt greenhouse technology while the perception of the farmer determines whether they adopt the technology or not.

## 2.8 Summary of Literature Review and Study Gaps

Literature reviewed previously in this chapter it clearly indicates that the changing climatic conditions have brought very unpredictable rainfall patterns that have frustrated many farmers. Consequently greenhouse technology may provide an alternative method of food production and generation of farm incomes (Kamau &Baumgartner, 2009).

Ashraf (2008) observed that the major obstacle towards the success of the greenhouse technology is finance. Paul (2001) suggested that before an individual contemplates on establishing a greenhouse, there is need to have adequate knowledge. Anuradha (2011) indicated that North America relies on tomatoes from greenhouse projects and they account for 30% of all the tomatoes consumed in the United States. Government supports fully its farmers and individuals through supplying them with quality materials for greenhouse technology projects. This explains why developed countries have effectively and efficiently enhanced food security to a point of donating food to the developing countries.

Borlaug (2000) indicates that, for there to be to end of world hunger and the general success in food security ,women should be encouraged to venture in agricultural projects like greenhouses so as to increase the maximum output annually however the general success in small scale industry in Africa and third world countries is more reliant on male gender than female gender, the notion that specific operations and technologies like greenhouse are meant for men who are the minority have by far weakened the fight against hunger.

Greenhouse technology should be embraced as a way of minimizing food insecurity in the country as it plays a key role in shifting from rain-fed farming to greenhouse for growing crops under controlled environment (Njagi, 2011). In Kenya, according to Ministry of Agriculture Strategic Plan (2009) there is low adoption of modern technologies such as greenhouse. In Gatitu Sub-Location in Nyeri Central District, Nyeri County only 16 farmers out of 667 farmers have greenhouses (MOA, 2011).

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter contains the research methodology that was used for the study. It specifically addressed the research design, the target population, sampling procedure, instruments of data collection, validity and reliability of the instrument, operationalization of variables, relevant methods of data analysis used and ethical issues.

## 3.2 Research Design

A research design can be described as the arrangement of conditions for collection and analysis of data in a manner that aims at combining relevance with the research purpose. In other words, research design is the conceptual structure within which research is conducted and constitutes the blue print for the collection, measurement and analysis of data (Kothari, 2004).

The researcher used descriptive survey design which involved collecting information by interviewing or administering questionnaires to a sample of individuals (Orodho, 2003).The main aim of using descriptive survey design in the study was to describe the state of affairs as it exists and then report the findings.

The researcher used both quantitative and qualitative methods for data collection. Both methods supplement each other in that qualitative method provided in-depth explanations while quantitative method provided the statistical data needed to meet required objectives (Mugenda and Mugenda, 2003).

### 3.3 Target Population

Population is a group of individuals, objects or items from which samples are taken for measurement (Kombo, 2009). In this research, target population was 667 farmers in Gatitu Sub-Location out of which 651 farmers had no greenhouses while 16 farmers had greenhouses (MOA, 2011).

### 3.4 Sample Size and Sampling Procedure

Sampling can be defined as a process of obtaining information about an entire population by examining only a part of it (Kothari, 2004). The items so selected constitute a sample. Sampling can also be defined as the procedure by which some elements of a given population are selected as representatives of the entire population (Copper and Schindleer, 2003).

A sample must be truly representative of population characteristics without any bias so that it may result in valid and reliable conclusions (Kothari, 2004). A sample can also be defined as a finite part of a statistical population whose properties are studied to gain information about the whole (Webster, 1985).

From the population of 651 farmers, 10% of the farmers were selected to form part of a sample of farmers without greenhouses which translated to 65 farmers or respondents. According to Mugenda and Mugenda (2003) a sample of 10% is a good representation of the total population since this study is a social study where descriptive survey design was used. In addition, all the 16 farmers with greenhouses were included to make a sample size of 81 respondents.

The researcher used both purposive and simple random sampling methods whereby the all the 16 farmers with greenhouses formed part of the sample since they possess more

information on greenhouse by the virtue of having the greenhouses and a census was done while the rest of the sample consisted of the farmers without greenhouses.

The farmers without greenhouses were selected randomly by taking a transect walk across the Sub-Location by picking a respondent after every five farms until the intended sample size was achieved. The researcher used simple random sampling because the population of farmers in Gatitu Sub-Location is relatively homogenous and there is no available data on the villages in this Sub-Location.

**Table 3.1: No of Respondents selected from the Sub-location**

| Sub-location | Number of farmers without greenhouses | 10% of the farmers without Greenhouses | Sample size |
|---|---|---|---|
| Gatitu | 651 | 65 | 65 |

### 3.5 Research Instruments and Methods

The researcher used questionnaires and observation guide as instruments for data collection. Questionnaires were used as an instrument of data collection because it presents an even stimulus to large number of respondents simultaneously and provides the researcher with easy accumulation of data thus making it less expensive. The questionnaires were short and had both closed and open ended questions which were in very simple language. The researcher also used observation guide to determine the level of technology of the greenhouse.

### 3.6 Validity

Validity is defined as the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda and Mugenda, 2003). To ensure that data collected reflect factual information on the ground in relation to various variables, simple language was used as much as possible. In addition, the questionnaires were analyzed by the experts in the university and the supervisors to ensure that they were valid.

### 3.7 Reliability

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials (Mugenda &Mugenda, 2003). To enhance reliability a pilot study was conducted in a neighbouring Sub-Location called Ruringu where a test – retest method was used to the same respondents after two weeks to determine the consistency of responses between the two tests and subsequently the researcher revised the questionnaires so as to get valid and reliable information from the respondents.

### 3.8 Data Collection Procedure

For effective data collection, the researcher used an introduction letter to assist her to seek for permission from the Assistant Chief in Gatitu Sub-Location, then identified the respondents and booked an appointment with them. On the appointment day, the researcher with the help of research assistants administered the questionnaires and and explained the contents of the questionnaires to the respondents so as to elicit a lot of information and at the same time capture in-depth information on the objectives of the study. Questionnaires were administered to respondents and then collected at a later date after an agreed time. The researcher and research assistants also used observation guide to note the level of technology of the greenhouses.

### 3.9 Data Analysis and Presentation

Data collected from the field was cleaned, coded, key-punched into a computer and analyzed. Both quantitative and qualitative data collected was analyzed using the descriptive statistics that helped to describe and summarize data by describing distribution of values or measurement using a few statistics. Qualitative data analysis was used to describe and discuss data pertaining to perception and attitude of farmers towards greenhouse technology using themes.

Descriptive statistics was used to analyze data collected and the results obtained were generalized to the whole population. Statistical data was analyzed with the help of electronic spreadsheet programme of Statistical Package of Social Sciences (SPSS). Content analysis of qualitative data was used to identify patterns and theme. The relationship between dependent and independent variables was analyzed using Pearson Product Moment Correlation. Finally, the data was presented using frequency distribution tables, ranks, mean and percentages.

### 3.10 Operationalization of Variables

The researcher identified necessary procedures and operations to measure a concept by looking at the behavioural dimensions, indicators and exhibited properties. The measures used were both objective and subjective.

## Table 3.2: Table of Operationalization of Variables

| Objective | Variable | Indicators | Measurement scale | Type of analysis |
|---|---|---|---|---|
| To assess current greenhouse practices | Adoption of greenhouse technology (dependent) | Number of greenhouses established<br>Level of technology of greenhouse<br>Type of Crops grown in the greenhouse | Ordinal<br>Nominal<br>Ordinal | Frequency distribution table<br>Standard Deviation<br>Percentages<br>mean<br>Pearson Product Moment Correlation |
| To assess how greenhouse financing influence adoption of greenhouse technology | Financing (independent variable) | Sources of credit<br>Access to credit<br>Influence of access to finance on adoption of greenhouse technology<br>Correlation between access to finance and level of technology | Ordinal<br>Ordinal<br>Ordinal<br>Ordinal | Frequency distribution table<br>Mean<br>Percentages<br>Standard Deviation<br>Pearson Product Moment Correlation |
| To establish how knowledge on greenhouse influences adoption of greenhouse technology | Knowledge (independent variable) | Sources of greenhouse knowledge<br>Access to greenhouse knowledge<br>Influence of access to greenhouse knowledge on adoption of greenhouse technology<br>Correlation between access to knowledge and level of technology | Ordinal<br>Ordinal<br>Ordinal<br>Ordinal | Percentages<br>Frequency Distribution Tables<br>Pearson Product Moment Correlation |
| To determine the extent to which the availability of greenhouse materials influences the adoption of greenhouse technology | Availability of greenhouse materials | Type of materials used<br>Sources of materials<br>Accessibility of materials<br>Influence of access to greenhouse materials on adoption of greenhouse technology | Ordinal<br>Ordinal<br>Ordinal<br>Ordinal | percentages<br>Frequency distribution table<br>Pearson Product Moment Correlation |
| To determine the extent to which gender issues influence adoption of greenhouse technology | Gender (independent variable) | Participation of men and women in decision making and provision of labour in the greenhouses<br>Adoption of greenhouse technology by men and women<br>Accessibility of credit by men and women | Ordinal<br>Ordinal<br>Ordinal | Percentages<br>Pearson Product Moment Correlation<br>Frequency Distribution Tables |

### 3.11 Ethical Issues

The researcher maintained a high degree of confidentiality where the identity of the respondents was protected. The researcher also obtained informed consent from every respondent in the study and ensured that they participated voluntarily. Relevant authorities were consulted through a letter of introduction entailing the purpose of the study and seek permission to collect the data.

### 3.12 Summary

The research design used is descriptive survey to assess the factors influencing the adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County. Questionnaires and Observation guide were used as research instruments. To ensure that data collected reflect factual information on the ground in relation to various variables, simple language was used as much as possible.

In addition, the questionnaires were analyzed by the experts in the university and the supervisors to ensure that they were valid. To enhance reliability a pilot study was conducted in a neighbouring Sub-Location called Ruringu where a test – retest method was used to the same respondents after two weeks to determine the consistency of responses between the two tests and subsequently the researcher revised the questionnaire in order to get valid and reliable information from the respondents. Operationalization of the variables was also explained. The data collected was analyzed using Statistical Package for Social Sciences (S.P.S.S).

# CHAPTER FOUR

# DATA ANALYSIS, PRESENTATION AND INTERPRETATION

## 4.1 Introduction

This chapter presents the findings of the study. The chapter covered the response rate, demographic data, current greenhouse practices, greenhouse financing, knowledge on greenhouse, availability of greenhouse material and gender issues on greenhouse technology. The responses were analyzed using descriptive statistics and data presented in frequency tables and percentages. Inferential statistics were also used and data presented using Pearson Product Moment Correlation coefficient.

## 4.2 Response Rate

The researcher administered 81 questionnaires to the respondents and all the questionnaires were filled and returned for data analysis. The success of high response rate of 100% was because the researcher self administered the questionnaires with the help of a trained research assistant.

## 4.3 Analysis of the demographic factors

The study looked into the gender, age, highest level of education, farm sizes and number of greenhouses of the respondents.

### 4.3.1 Response by Gender

The results in Table 4.1 shows that most of the respondents 51.9% were males while 48.1% were females. The researcher found this insignificant to constitute gender bias since the percentage of the male and female respondents was almost equal.

**Table 4.1 Distribution of the respondents by gender**

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 42 | 51.9 |
| Female | 39 | 48.1 |
| Total | 81 | 100.0 |

### 4.3.2 Response by Age

Table 4.2 shows that majority of respondents 31.3% were between 30-39 years of age, 28.0% in the 40-49 age group ,16.0% were 60 and above years and only 3.7 were in the age group of 18-29 years.

**Table 4.2 Distribution of Respondents by Age**

| Age (Years) | Frequency | Percentage |
|---|---|---|
| 18-29 | 3 | 3.7 |
| 30-39 | 25 | 31.3 |
| 40-49 | 23 | 28.0 |
| 50-59 | 17 | 21.0 |
| 60 and Above | 13 | 16.0 |
| Total | 81 | 100 |

### 4.3.3 Highest Level of Education of Respondents

Table 4.3 shows that a significant majority of the respondents 45.7% had attained secondary education, 25.9% primary education,17.3 diploma, 3.7% had certificate education,3.7% had a degree and above and only 3.7 % with adult education.

**Table 4.3 Highest Education Level of Respondents**

| Highest Level of Education | Frequency | Percent |
|---|---|---|
| Adult Education | 3 | 3.7 |
| Primary | 21 | 25.9 |
| Secondary | 37 | 45.7 |
| Certificate | 3 | 3.7 |
| Diploma | 14 | 17.3 |
| Degree and above | 3 | 3.7 |
| Total | 81 | 100.0 |

### 4. 3.4 Sizes of Farms Owned by the Respondents

Table 4.4 shows that majority of the respondents 44.4% had one acre to five acres, 43.2% had less than one acre of land while only 10% had more than five acres of land.

**Table 4.4 Sizes of Farms Owned by the Respondents**

| Size of the Farm | Frequency | Percent |
|---|---|---|
| Less than One Acre | 35 | 43.2 |
| One Acre to 5 Acres | 36 | 44.4 |
| Above 5 Acres | 10 | 12.4 |
| Total | 81 | 100.0 |

## 4.4 Current Greenhouse Farming Practices

### 4.4.1 Age of the respondents with greenhouses

Table 4.5 show that majority of greenhouse farmers 37% are between 40-49 years, 31% between 50-59 years, 13% between 30-39 years,19% were 60 and above while none below 29 years. This indicates that most of young people are not engaging in greenhouse farming.

**Table 4.5 Age of Respondents with Greenhouse**

| Age (Years) | Frequency | Percentage |
|---|---|---|
| 18-29 | 0 | 0 |
| 30-39 | 2 | 13 |
| 40-49 | 6 | 37 |
| 50-59 | 5 | 31 |
| 60 and Above | 3 | 19 |
| Total | 16 | 100 |

### 4.4.2 Sizes of Farms Owned by the respondents with greenhouses

Table 4.6 shows that significant majority of the greenhouse owners 75.00% had less than one acre of land, 18.75% had One Acre to 5 Acres and 6.25% had above 5 Acres. This is therefore an indication that greenhouse technology is a very good technology for those farmers with very small farm because they are able to maximize yields and returns per unit area of land.

**Table 4.6 Sizes of Farms Owned by the Greenhouse Owners**

| Size of the Farm | Frequency | Percent |
|---|---|---|
| Less than One Acre | 12 | 75.00 |
| One Acre to 5 Acres | 3 | 18.75 |
| Above 5 Acres | 1 | 6.25 |
| Total | 16 | 100.0 |

### 4.4.3 Number of Greenhouses owned by Greenhouse Owners

Table 4.7 shows that majority of the respondents with greenhouses 68.75% had only one greenhouse while 31.25 had more than one. What the researcher gathered as the reason for this was that greenhouse farming is an expensive venture and that there is inadequate access to affordable credit to establish and manage more than one greenhouse.

**Table 4.7 Number of Greenhouses owned by Greenhouse Owners**

| Size of the Farm | Frequency | Percent |
|---|---|---|
| One | 11 | 68.75 |
| More than one | 5 | 31.25 |
| Total | 16 | 100.0 |

### 4.4.4 Types of crops that were being grown in Greenhouses

Respondents with greenhouses were growing tomatoes, capsicum and coughettes. However the commonest crop in most of greenhouses was tomatoes.

### 4.4.5 Purpose for Greenhouse Crops

Table 4.8 shows that, 44 percent established greenhouse for income generation, 37 percent for both food and income, and 13 percent as self employment while 6 percent as a hobby. Majority of greenhouse owners practice greenhouse farming for income generation and for food security meaning that greenhouse farming makes a good business and it is also a good source of food especially the vegetables.

**Table 4.8 Purpose for Greenhouse Crops**

| Purpose For Greenhouse Crops | Frequency | Percentage |
|---|---|---|
| For food | 0 | 0 |
| For income generation | 7 | 44 |
| For both food and income | 6 | 37 |
| For self employment | 2 | 13 |
| As a hobby | 1 | 6 |
| Total | 16 | 100 |

### 4.4.6 Contribution of Greenhouse Technology towards Food Security

Table 4.9 indicates that 75% of the greenhouse owners said that greenhouse farming contribute highly to food security.

Those who felt its contribution to food security was moderate were 18.75%. This implied that the combined high and moderate contribution was felt by an overwhelming 93.75%. No respondent felt that green house technology contributed nothing to food security. Overall the findings show that greenhouse technology contributes significantly to food security.

**Table 4.9 Contribution of Greenhouse Technology towards Food Security**

| Contribution to Food Security | Frequency | Percentage |
|---|---|---|
| High | 12 | 75.0 |
| Moderate | 3 | 18.75 |
| Neutral | 0 | 0 |
| Low | 1 | 6.25 |
| Not at all | 0 | 0 |
| Total | 16 | 100 |

### 4.5 Greenhouse Financing

#### 4.5.1 Greenhouse Financing

Table 4.10 shows that, 31 percent of greenhouse owners source of finance was savings, 6 percent pension, 25 percent from family members, and 38 percent from loans. The findings of the study indicated that majority of the farmers depended on loans as the main source of capital for investing in greenhouse technology.

**Table 4.10 Financing of Greenhouse**

| Sources of Finance | Frequency | Percentage |
|---|---|---|
| Savings | 5 | 31 |
| Pension | 1 | 6 |
| Salary | 0 | 0 |
| Family | 4 | 25 |
| Loan | 6 | 38 |
| Others[specify] | 0 | 0 |
| Total | 16 | 100 |

#### 4.5.2 Access to Credit for Greenhouse Technology

Table 4.11 indicates that significant majority of the respondents 50.6% disagreed that access to credit from financial institutions was easy, 6.2% strongly disagreed,28.4% had no idea about the accessibility of credit for greenhouse technology while only 13.6% and 1.2% agreed and strongly agreed that credit was easily accessible from financial institutions. The reasons for disagreeing were lack of security or collateral, interest rate are too high /unaffordable, fear that one might not be able to service the loan.

**Table 4.11 Access to Credit for Greenhouse technology**

| Access to Credit from a Financial Institution is easy | Frequency | Percentage |
|---|---|---|
| Strongly Disagree | 5 | 6.2 |
| Disagree | 41 | 50.6 |
| Neutral | 23 | 28.4 |
| Agree | 11 | 13.6 |
| Strongly Agree | 1 | 1.2 |
| Total | 81 | 100 |

### 4.5.3 Influence of access to finance to Adoption of Greenhouse

Table 4.12 shows that, a total 96.3% respondent strongly agreed and agreed that access to finance influence adoption of greenhouse technology, 1.2% were neutral meaning that they had no idea and only 2.5% of the respondents disagreed. Lack of access to finance seems to be the biggest impediment to adoption of greenhouse technology.

**Table 4.12 Influence of Access to Finance to Adoption of Greenhouse**

| Influence of access to Finance on Adoption of Greenhouse Technology | Frequency | Percentage |
|---|---|---|
| Strongly Disagree | 0 | 0 |
| Disagree | 2 | 2.5 |
| Neutral | 1 | 1.2 |
| Agree | 25 | 30.9 |
| Strongly Agree | 53 | 65.4 |
| Total | 81 | 100 |

## 4.6 Knowledge on Greenhouse Technology

### 4.6.1 Highest Education Level of Respondents with Greenhouses

Table 4.13 shows that, majority of greenhouse owners were learned with 50 percent having diploma, 13 percent had degrees and above, 6 percent had certificate and 6 percent being graduates of adult education. The finding showed that adoption of greenhouse technology requires certain level of education so as to understand and acquire knowledge on the technology.

**Table 4.13 Highest Education Level of Respondents with Greenhouses**

| Highest Level of Education | Frequency | Percent |
|---|---|---|
| Adult Education | 1 | 6 |
| Primary | 0 | 0 |
| Secondary | 4 | 25 |
| Certificate | 1 | 6 |
| Diploma | 8 | 50 |
| Degree and above | 2 | 13 |
| Total | 16 | 100 |

### 4.6.2 Sources of Knowledge on Greenhouse Technology

Table 4.14 indicates that majority of respondents 36.9% obtained knowledge on greenhouse technology from the media, 28.7% from the Government Agricultural Officers, 21.7% from other farmers and 12.6% from private Extension providers. Majority of the respondents said that they were getting knowledge on greenhouse from media mainly the local FM radio stations like Inooro and Coro. They also said that Government Agricultural Officers should educate them on greenhouse technology by organizing trainings for them.

**Table 4.14 Sources of Knowledge on Greenhouse Technology**

| Source of Knowledge on Greenhouse Technology | Frequency | Percentage |
|---|---|---|
| Other Farmers | 19 | 21.8 |
| Government Agricultural Officers | 25 | 28.7 |
| Private Extension Providers | 11 | 12.6 |
| Media | 32 | 36.9 |
| Internet | 0 | 0 |
| All of the Above | 0 | 0 |
| None | 0 | 0 |
| Total | 87 | 100 |

### 4.6.3 Access to Knowledge on Greenhouse Technology

Table 4.15 shows that majority of the respondent 44.5% felt that knowledge on greenhouse was inaccessible, 25.9% had no idea on the accessibility of greenhouse knowledge,

16% felt that it was extremely inaccessible while only 13.6 % felt that it was accessible and extremely accessible. Those respondents who felt that knowledge on greenhouse was either inaccessible or extremely inaccessible 60.5% said that they do not get adequate extension services from the Government Agricultural Officers.

**Table 4.15 Access to Knowledge on Greenhouse Technology**

| Access to Knowledge on Greenhouse Technology | Frequency | Percentage |
|---|---|---|
| Extremely inaccessible | 13 | 16.0 |
| Inaccessible | 36 | 44.5 |
| Don't know | 21 | 25.9 |
| Accessible | 9 | 11.1 |
| Extremely accessible | 2 | 2.5 |
| Total | 81 | 100 |

### 4.6.4 Influence of access to Greenhouse Knowledge on Adoption of Greenhouse Technology

Table 4.16 shows that 54% of respondents strongly agreed that access on greenhouse knowledge influences adoption of greenhouse technology, 30.9% agreed, only3.7% and 1.2% who disagreed and strongly disagreed respectively and 9.9% were neutral.

On how access to knowledge can be improved to make more farmers adopt greenhouse technology, the farmers said, trainings to be organized to teach farmers on greenhouse farming and run greenhouse programs in the media.

**Table 4.16 Influence of access to Greenhouse Knowledge on Adoption of Greenhouse Technology**

| Influence of Access to Knowledge on Adoption of Greenhouse Technology | Frequency | Percentage |
|---|---|---|
| Strongly agree | 44 | 54.4 |
| Agree | 25 | 30.9 |
| Neutral | 8 | 9.9 |
| Disagree | 3 | 3.7 |
| Strongly disagree | 1 | 1.2 |
| Total | 81 | 100 |

### 4.7 Availability of Greenhouse Material

#### 4.7.1 Materials Used in Greenhouse

Table 4.17 shows the materials used in the green houses, 31% are using new and 69% second hand materials. The reason of using second hand was that the materials are expensive.

**Table 4.17 Materials Used in Greenhouse**

| Materials Used in Greenhouse | Frequency | Percentage |
|---|---|---|
| New | 5 | 31 |
| Second hand | 11 | 69 |
| Total | 16 | 100 |

#### 4.7.2 Sources of Greenhouse materials for respondents with greenhouses

Table 4.18 indicates that 18.75 percent of the greenhouse owners purchased their materials from Nairobi, 68.75 percent from Naivasha and 12.50 percent from other sources that the respondents said was Amiran Kenya Limited which is a private service provider that sells greenhouse materials to the willing farmers and deliver to their farms as well as providing extension services to them. The respondents also said that the new ones are obtained from Nairobi and the second hand ones from Naivasha thus making them even more expensive due to transport cost.

**Table 4.18: Sources of Greenhouse materials for respondents with greenhouses**

| Sources of greenhouse materials | Frequency | Percentage |
|---|---|---|
| Nyeri | 0 | 0 |
| Nairobi | 3 | 18.75 |
| Naivasha | 11 | 68.75 |
| Others | 2 | 12.50 |
| Total | 16 | 100.00 |

### 4.7.3 Access to Greenhouse Materials

Table 4.19 depicts that most of the respondents 46.9% said that greenhouse materials were inaccessible or extremely inaccessible while a total of 37.1% said that materials were accessible and extremely accessible from Nairobi and Naivasha so long as one had enough capital since they are expensive. 13.6% had no idea about the accessibility of the material because they had no thought of adopting greenhouse technology by then.

**Table 4.19: Access to Greenhouse Materials**

| Access to Greenhouse Materials | Frequency | Percentage |
|---|---|---|
| Extremely inaccessible | 8 | 9.9 |
| Inaccessible | 30 | 37.0 |
| Don't know | 13 | 16.0 |
| Accessible | 19 | 23.5 |
| Extremely accessible | 11 | 13.6 |
| Total | 81 | 100 |

### 4.7.4 Influence of Access to Greenhouse Materials on Adoption of Greenhouse Technology

Table 4.20 shows that most of the respondents 51.9% agreed that access to greenhouse materials influence adoption of greenhouse technology with 38.2% ,only 7.4% of the respondents disagreed. However 2.5% were not sure whether access to greenhouse materials influences adoption of greenhouse technology or not.

**Table 4.20 Influence of Access to greenhouse Greenhouse Materials on Adoption of Greenhouse Technology**

| Influence of Access to Greenhouse Materials on Adoption of Greenhouse Technology | Frequency | Percentage |
|---|---|---|
| Strongly agree | 31 | 38.2 |
| Agree | 42 | 51.9 |
| Neutral | 6 | 7.4 |
| Disagree | 2 | 2.5 |
| Strongly disagree | 0 | 0 |
| Total | 81 | 100 |

### 4.8 Gender Issues on Adoption of Greenhouse Technology

#### 4.8.1 Decision on Establishment of a Greenhouse

Table 4.21 shows in 44% of farms, decision of establishment of a greenhouse was made by male, 19% by female and 37% by both male and female. The reason of males being the majority decision makers of establishment of greenhouse was that they are the majority legal farm owners.

**Table 4.21 Decision on Establishment of a Greenhouse**

| Decision on Establishment of a Greenhouse | Frequency | Percentage |
|---|---|---|
| Male | 7 | 44 |
| Female | 3 | 19 |
| Both | 6 | 37 |
| TOTAL | 16 | 100 |

#### 4.8.2 Owner of Greenhouse

Table 4.22 shows that, 50% male owns the greenhouse, 13% are owned by female, 37% by both male and female. The respondents said that most of the greenhouses are owned by men because they have more access to credit than the women by the fact that majority of the men at the household level possess the collaterals required by the financial institutions as the security for the loans.

**Table 4.22 Owner of Greenhouse**

| Owner of Greenhouse | Frequency | Percentage |
|---|---|---|
| Male | 8 | 50 |
| Female | 2 | 13 |
| Both | 6 | 37 |
| Total | 16 | 100 |

### 4.8.3 Provision of labour in the Greenhouse

Table 4.23 indicates that, 12 percent of greenhouses were taken care of by males, 19 percent by females while in 69 percent was both. In this case there is more involvement of females in the provision of labour than men; the reason given was that more women were left at the farm as men went to work outside the farms.

**Table 4.23 Provision of labour in the Greenhouse**

| Provision of labour in the Greenhouse | Frequency | Percentage |
|---|---|---|
| Male | 2 | 12 |
| Female | 3 | 19 |
| Both | 11 | 69 |
| Total | 16 | 100 |

### 4.8.4 Controller of Greenhouse Income

Table 4.24 shows that, 44 percent greenhouse income is controlled by male, 31 percent by female and 25 percent were controlled by both male and female.

Majority of controllers of greenhouse income was males and the reason given was that they are the majority decision makers of the households.

**Table 4.24 Controller of Greenhouse Income**

| Controller of Income | Frequency | Percentage |
|---|---|---|
| Male | 7 | 44 |
| Female | 5 | 31 |
| Both | 4 | 25 |
| Total | 16 | 100 |

### 4.8.5 Access to Credit for Green house

Table 4.25 shows that, 69 percent of greenhouse owners felt that the male can access credit easily as compared to female 19 percent. The main reason given by the respondents was that males had collaterals required by the financial institution as the security for the credit/finance.

**Table 4.25 Access to Credit for Green house**

| Who Amongst the Gender can Access Credit easily | Frequency | Percentage |
|---|---|---|
| Male | 11 | 69 |
| Female | 3 | 19 |
| Both | 2 | 12 |
| TOTAL | 16 | 100 |

## 4.9 Level of Greenhouse Technology Adopted

Based on observation, the study ranked the level of greenhouse technology adopted by using the parameters in the observation guide.

### 4.9.1 Level of Greenhouse Technology Adopted

Table 4.26 shows that, 6 percent of greenhouse adopted a high technology, 13 percent medium, 50 percent low technology and 31 percent very low technology. Most of these greenhouses are of low technology where the farmer uses wooden poles and second hand polythene paper as the covering material.

**Table 4.26 Level of Greenhouse Technology Adopted**

| Level of Greenhouse Technology Adopted | Frequency | Percentage |
|---|---|---|
| Very High | 0 | 0 |
| High | 1 | 6 |
| Medium | 2 | 13 |
| Low | 8 | 50 |
| Very Low | 5 | 31 |
| TOTAL | 16 | 100 |

## 4.10 Hypotheses Testing

### 4.10.1 Correlation between Access to Finance and the Level of Greenhouse Technology Adopted

Pearson Product moment was used to test the first hypothesis, that is, access to credit does not significantly influence adoption of greenhouse technology in Nyeri Central district.

**Table 4.27 Relationship between Access to Finance and the Level of Greenhouse Technology Adopted**

| Access to Credit from Financial Institution is Easy | Percentage Variable X | Level of Greenhouse Technology Adopted | Percentage Variable Y |
|---|---|---|---|
| Strongly Disagree | 0 | Very High | 0 |
| Disagree | 13 | High | 6 |
| Neutral | 0 | Medium | 13 |
| Agree | 81 | Low | 50 |
| Strongly agree | 6 | Very Low | 31 |
| Total | 100 | | 100 |

**Pearson Product Moment Correlation**

| Statistic | Variable X | Variable Y |
|---|---|---|
| Mean | 20 | 20 |
| Variance | 533.2 | 333.2 |
| Standard Deviation | 23.091 | 18.25 |
| Correlation Coefficient | 0.7421 | |

The calculated Pearson Product Moment Correlation coefficient of 0.7421 implies that, there is a strong correlation between access to credit/finance and the level of greenhouse technology adopted. Therefore the null hypothesis was rejected and accepted the alternative hypothesis which means that, access to credit significantly influence the level of greenhouse technology adopted in Gatitu Sub- Location in Nyeri Central District.

### 4.10.2 Correlation between Access to Knowledge on Greenhouse Technology and Level of Greenhouse Technology Adopted

Pearson Product moment was used to test the first hypothesis, that is, access of knowledge on greenhouse does not significantly influence adoption of greenhouse technology in Nyeri Central district.

**Table 4.28 Relationship between Access to Knowledge of Greenhouse Technology and Level of Greenhouse Technology Adopted**

| Access to Knowledge of Greenhouse Technology | Percentage Variable X | Level of Greenhouse Technology Adopted | Percentage Variable Y |
|---|---|---|---|
| Extremely inaccessible | 13 | Very High | 0 |
| Inaccessible | 56 | High | 6 |
| Don't know | 25 | Medium | 13 |
| Accessible | 6 | Low | 50 |
| Extremely accessible | 0 | Very Low | 31 |
| Total | 100 | | 100 |

**Pearson Product Moment Correlation**

| **Statistic** | **Variable X** | **Variable Y** |
|---|---|---|
| Mean | 20 | 20 |
| Variance | 393.2 | 333.2 |
| Standard Deviation | 19.83 | 18.25 |
| Correlation Coefficient | -0.574 | |

The calculated Pearson Product Moment Correlation coefficient of -0.574 implies that, there is an inverse correlation between access to knowledge and adoption of greenhouse technology. Therefore the null hypothesis is accepted and we reject the alternative hypothesis which means that, access to knowledge does not significantly influence the level of greenhouse technology adopted in Gatitu Sub-location in Nyeri Central District, Nyeri County.

# CHAPTER FIVE

# SUMMARY OF THE FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

The basic purpose of this chapter was to give the summary, discussion, conclusions and recommendation of the study. This was based on the research findings that is presented and discussed in the previous chapters.

## 5.2 Summary of the findings

There was a high response rate of 100%. The study looked into the gender, age, highest level of education, farm sizes and number of greenhouses of the respondents.

The findings of this study revealed that, majority of greenhouse owners were males as compared to females. In addition majority of greenhouse farmers were not youthful with most being over 40 years. Majority of greenhouse owners were learned with diploma, degrees, certificate and some graduates of adult education. This study concludes that, greenhouse technology adoption is low among the uneducated ones.

The main reason for farmers to invest in greenhouse technology, 44% established greenhouse for income generation, 37% for food and income, 13% for self employment and 6% as a hobby.The findings of the study also revealed that majority of farmers depended on loans as a source of capital for investing in greenhouse technology. In addition, it is not easy to access credit from the financial institution due to lack of security or collateral, interest rate are too high /unaffordable, and fear of not being able to service the loan.

The calculated Pearson Product Moment Correlation coefficient of 0.7687 implied that, there is a strong correlation between access to credit and the level of greenhouse technology adopted.

The calculated Pearson Product Moment Correlation coefficient of -0.574 implied that, there is an inverse correlation between access to knowledge and the level of greenhouse technology adopted.

Most of farmers are using second hand materials instead of new materials. The reason of using second hand materials was that, the materials were expensive and new materials are not available locally. Majority of farmers agreed that accessibility of materials influence adoption of greenhouse technology.

More women than men provide labour in greenhouse despite being minority decision makers and owners. These findings therefore revealed that there is unequal participation between men and women in decision making and control of income from greenhouse farming.

The study also found that adoption of greenhouse technology was low and at very low technology levels in Gatitu Sub-location in Nyeri Central District, Nyeri County.

### 5.3 Discussion of the Findings

The study recorded high response rate of 100 % and according to Linder and Wingenbanch (2002), surveys that have high response rates provide a measure of reassurance that the findings can be projected to the population from which the sample is drawn. The success of high response rate of 100% was because the researcher self administered the questionnaires with the help of a trained research assistant to the respondents. Most of the respondents 51.9% were males while 48.1% were females. The researcher found this insignificant to constitute gender bias since the percentage of the male and female respondents was almost equal.

Majority of respondents 31.3% were between 30-39 years of age.

The study objective one sought to assess the current greenhouse practices in Gatitu Sub-Location in Nyeri Central District, Nyeri County. The findings of this study in table 4.1 revealed that majority of greenhouse farmers 37% are between 40-49 years, 31% between 50-59 years,13% between 30-39 years,19% were 60 and above while none below 29 years. This indicates that most of young people are not engaging in greenhouse farming and that majority of greenhouse owners were males, 56 percent, while 44 percent were females. This indicated that greenhouse technology was a male dominated activity though the dominance was not so pronounced. The finding concurs with a study by Paul (2001) which observed that women and girls have been underestimated especially in the developing world to be incompetent in agricultural technologies as they are viewed as men's business. The finding also concurred with annual report by Ministry of Agriculture, Nyeri Central District (2011) which indicated that majority of greenhouses were owned by men.

Majority of greenhouse owners were learned with 50 percent with diploma, 13 percent had degrees and above, 6 percent had certificate and 6 percent being graduates of adult education.. This meant greenhouse technology adoption was low among the uneducated ones. This study therefore revealed that farmers require some level of education to comprehend greenhouse technology and it was observed that the higher the level of education, the easier it is to adopt and use the technology. A study by Paul (2001) suggested that before an individual contemplates on establishing a greenhouse, there is need to have adequate knowledge which agrees with the findings of this study.

Significant majority of the greenhouse owners 75.00% had less than one acre of land, 18.75% had One Acre to 5 Acres and 6.25% had above 5 Acres. This is therefore an indication that greenhouse technology is a very good technology particularly for those farmers with very

small farm because they are able to maximize yields and returns per unit area of land. Majority of the greenhouse owners (68.75%) had only one greenhouse. What the researcher gathered as the reason for this was that greenhouse farming is an expensive venture and that there is inadequate access to affordable credit to establish and manage more than one greenhouse. The outcome is supported by a study done by Clifton (2004) which found out that a greenhouse requires higher capital to establish, run and maintain to serve the intended purpose efficiently than the traditional farming methodology in open land and natural weather conditions.

The results of the study also showed that main reason for farmers to invest in greenhouse technology, 44 % was for income generation, 37 percent for both food and income, and 13 percent as self employment while 6 percent as a hobby. These farmers had mostly grown tomatoes and a few growing capsicums and cougettes. The findings concurred with study done by Kamau &Baumgartner (2009) which stated that the changing climatic conditions have brought about very unpredictable rainfall patterns and frustrated many farmers who depend on rain fed crop production and that under optimal conditions, growing vegetables and fruits in a greenhouse can give the farmers up to ten times what they would get if they did the same in an open rain fed field. Due to severe food shortage mainly because of prolonged drought, greenhouse vegetables have become a solution for rural communities in Kenya.

Table 4.7 indicates that 75% of the greenhouse owners said that greenhouse farming contribute highly to food security. Those who felt its contribution to food security was moderate were 18.75%. This implied that the combined high and moderate contribution was felt by an overwhelming 93.75%.Overall the findings show that greenhouse technology contributes significantly to food security. This is supported by a study done by Prajad (2010) that showed

that use of technology in Asia especially in India on greenhouse have enabled the country to conquer food insecurity. Study by Njagi (2011) also stated that greenhouse technology should be embraced as a way of minimizing food insecurity in the country as it plays a key role in shifting from rain-fed farming to greenhouse for growing crops under controlled environment

The study objective two sought to assess how financing of greenhouse influences adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County. The study found out that, 31 percent of greenhouse owners' source of finance was savings, 6 percent pension, 25 percent from family members, and 38 percent from loans. This therefore meant that, majority of farmers depended on loans as a source of capital for investing in greenhouse technology. This finding concurred with the studies by both Tall (2008) which indicated that starting a greenhouse is very expensive and Bhupendra, (2007) which indicated that the inputs required in maintenance of greenhouse are expensive.

A significant majority of the respondents 50.6% said that access to credit from financial institutions was difficult because of lack of security or collateral, interest rates were too high /unaffordable, and fear of not being able to service the loan. This is in line with a study done by KARI (2008) which found out that in Kenya today, various types of greenhouses come with valid high costs which very few people can afford since majority are low and medium class earners. A total 96.3% respondent strongly agreed and agreed that access to finance influence adoption of greenhouse technology. This revealed that, finance seemed to be the biggest impediment to adoption of greenhouse technology.

The study objective three sought to establish whether knowledge on greenhouse influenced the adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central

District, Nyeri County.The study found out that majority of respondents 36.9% obtained knowledge on greenhouse technology from the media, 28.7% from the Government Agricultural Officers, 21.7% from other farmers and 12.6% from private Extension providers. Respondents getting knowledge on greenhouse from media said that their main sources were the local FM radio stations like Inooro and Coro. They also said that Government Agricultural Officers were not easily available to them.The findings concurred with the study by Thompson (2010) greenhouses in Kenya have been mostly affected by farmers lacking enough knowledge on the fundamental process operations, procedures required in a greenhouse.

On the access of greenhouse technology 44.5% of the respondent felt that knowledge on greenhouse was inaccessible, 25.9% had no idea on the accessibility of greenhouse knowledge, 16% felt that it was extremely inaccessible while only 13.6 % felt that it was accessible and extremely accessible. Majority of respondents 60.5% felt that knowledge on greenhouse was either inaccessible or extremely inaccessible because they were not getting adequate extension services from the Government Agricultural Officers. 54% of respondents strongly agreed that access on greenhouse knowledge influences adoption of greenhouse technology, 30.9% agreed, only 3.7% and 1.2% who disagreed and strongly disagreed respectively and 9.9% were neutral.
On how access to knowledge the farmers said that, Ministry of Agriculture should be organized for trainings on greenhouse technology, demonstrations on greenhouse farming and run greenhouse sensitization program in the media. This is with agreement with the study by Paul (2001) that suggested that before an individual contemplates on establishing a greenhouse, there is need to have adequate knowledge. Similarly a report by the Government of Kenya (2009)

through Ministry of Agriculture strategic plan also indicated that implementation of the modern technologies goes hand in hand with training.

Research objective four aimed at determining the extent to which the availability of greenhouse materials influences the adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County. The findings of this study revealed that, 31% of the respondents with greenhouses had used new materials while 69% had used second hand materials. The reason of using second hand was that the materials are expensive. 18.75 % of the greenhouse owners purchased their materials from Nairobi, 68.75 percent from Naivasha and 12.50 percent from other sources that the respondents said was Amiran Kenya Limited which is a private service provider that sells greenhouse materials to the willing farmers and deliver to their farms as well as providing extension services to them. The respondents also said that the new materials were obtained from Nairobi and the second hand ones from Naivasha thus making them even more expensive due to transport cost. The results of the this study also found that greenhouse materials were not easily accessible to the farmers because they were only available from Nairobi and Naivasha.

These findings concurred with those of the Ministry of Agriculture Nyeri Central annual report (2011) on adoption of greenhouse technology, which found out that, lack of materials for the same was highlighted as a major problem. Sigh (2009) also agrees with the findings as he stated that, greenhouse materials availability is the starting point of a successful venture. Results of the findings indicated that access to greenhouse materials influence adoption of greenhouse technology to great extent because most of the respondents 51.9% agreed that access to greenhouse materials influence adoption of greenhouse technology with 38.2% ,only 7.4% of the

respondents disagreed. These findings were in agreement with study by Taft (2011) which noted that raw material in a greenhouse is a fundamental success tool which needs to be well organized financially and technically. The findings are also supported by Anuradha (2011) that indicated that North America relies on tomatoes from greenhouse projects and they account for 30% of all the tomatoes consumed in the United States where Government supports fully its farmers and individuals through supplying them with quality materials for greenhouse technology projects. This explains why developed countries have effectively and efficiently enhanced food security to a point of donating food to the developing countries

The study objective five aimed at establishing the extent to which gender issues influence adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County. This study found out that, in 44% of farms, decision of establishment of a greenhouse was made by male, 19% by female and 37% by both male and female. In terms of ownership, 50% of male owns the greenhouse, 13% are owned by female, 37% were owned by both male and female. According to the respondents most of the greenhouses are owned by men because they have more access to credit than the women by the fact that majority of the men at the household level possess the collaterals required by the financial institutions as the security for the loans.

The findings agreed with studies by Borlaug (2000) which indicated that, for there to be an end of world hunger and the general success in security ,women should be encouraged to venture in agricultural projects like greenhouses so as to increase the maximum output annually however the general success in small scale industry in Africa and third world countries is more reliant on male gender than female gender, the notion that specific operations and technologies like greenhouse are meant for men who are the minority have by far weakened the fight against

hunger and Paul (2001) which observed that women and girls have been underestimated especially in the developing world to be incompetent in agricultural technologies as they are viewed as men's business.

The study also found out that in 12 % of greenhouses labour was being provided by males, 19 percent by females while in 69 percent was both. This showed that more women than men were providing labour for greenhouses despite being minority decision makers and owners. On who controls the income from greenhouses, 44 percent greenhouse income was controlled by male, 31 percent by female and 25 percent were controlled by both male and female.

On access to credit, 69 percent of greenhouse owners felt that the men can access credit easily as compared to female 19 percent. These findings revealed that there is unequal participation between men and women in decision making and control of income from greenhouse farming thus marginalization of women in greenhouse farming.

Based on observation, the study ranked the level of greenhouse technology adopted using the observation schedule. It was found out that, 6 percent of greenhouse adopted a high technology, 13 percent medium, 50 percent low technology and 31 percent very low technology. The calculated Pearson Product Moment Correlation coefficient of 0.7421 implied that, there was a strong correlation between access to credit and the level of greenhouse technology adopted. Therefore the null hypothesis was rejected and accepted the alternative hypothesis which meant that access to credit significantly influenced the level of greenhouse technology adopted in Gatitu Sub-Location, Nyeri Central District. This study concurred with Ashraf (2008), observed that the major obstacle towards the success of the greenhouse technology was finance. A study by Bhupendra, (2007) indicated that the inputs required in maintenance of greenhouse were more expensive. The findings also is in line with the Ministry of Agriculture Nyeri Central

District (2011), which revealed that, some farmers have been forced to abandon greenhouse projects as a result of lack of funds.

The calculated Pearson Product Moment Correlation coefficient of -0.574 implied that there was an inverse correlation between access to knowledge and the level of greenhouse technology adopted. Therefore the null hypothesis was accepted and rejected the alternative hypothesis which meant that access to knowledge does not significantly influence the level of greenhouse technology adopted in Gatitu Sub-Location in Nyeri Central District, Nyeri County. These findings negated a study by Lakshmi (2004) which observed that majority of greenhouses fail to succeed even after establishment due to the limited knowledge by farmers.

**5.4 Conclusions**

The researcher concludes that majority of greenhouse owners were males as compared to females. In addition, majority of greenhouse farmers were not youthful with most being over 40 years. Majority of greenhouse owners were learned with diploma, degrees, certificate and some graduates of adult education. The study concludes that, greenhouse technology adoption is low among the uneducated and that adoption of greenhouse technology requires certain level of education so as to understand and acquire knowledge on the technology.

Farmers' trainings by the Ministry of Agriculture and other stakeholders like the private extension providers are inadequate.

The researcher also concludes that majority of the farmers invest on greenhouse technology for income generation also for food security meaning that it is a very important modern farming technology for enhancement of job creation/employment, food security, wealth creation and poverty reduction at household level and whole country at large.

The research also showed that majority of farmers with greenhouses had only one greenhouse where they were growing tomatoes, capsicums and courgettes and had mainly used second hand covering material due to cost. To make the matter worse both the new and old greenhouse covering materials were not locally available to farmers. Majority depended on loans as a source of capital for investing in greenhouse technology. In addition, it is not easy to access credit from the financial institution due to lack of security or collateral, interest rate are too high /unaffordable, and fear of not being able to service the loan. Access to finance/credit was cited as the major great hindrance towards adoption of greenhouse technology by farmers in Gatitu Sub-Location in Nyeri Central District, Nyeri County.

More women than men were taking care of greenhouse despite being minority decision makers and owners which depicted unequal participation between men and women in decision making and control of income from greenhouse farming which is an indication of marginalization of women in greenhouse farming.

Lastly the researcher concludes that adoption of greenhouse technology was low and at very low technology levels in Gatitu Sub-location in Nyeri Central District, Nyeri County.

### 5.5 Recommendations

Kenya is a developing country whose unemployed population is high; greenhouse technology projects would create job opportunities for many such Kenyans particularly the youth thus improving their standards of living and ensuring food security for all. The study found out that the number of farmers with greenhouses was very low and also at very low level of technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County.

To improve the rate of adoption of greenhouse technology in Gatitu Sub-location in Nyeri Central District, Nyeri County the researcher makes the following recommendations:

1. In order to improve the access to finance/credit to the farmers, Ministry of Finance in collaboration with the financial institutions should make credit more accessible and affordable to farmers.

2. To improve access to greenhouse knowledge to farmers Ministry of Agriculture in collaboration with other stakeholders like Armilan Kenya Limited who are private extension providers should organize for more education and trainings for the farmers to ducate them and also promote greenhouse technology.

3. Kenya Agricultural Research Institute come up with greenhouse models that are more affordable to the small scale farmers and set demonstrations at the Government Agricultural Centres like Wambugu Agricultural Training Centre in Nyeri Central District where farmers can be going to see these models and also learn.

4. Ministry of Agriculture should also come up with programmes on greenhouse technology in the media especially in the local language FM radio Stations to ensure more training and coverage of the farmers.

5. To improve availability and access to greenhouse materials Ministry of Agriculture in collaboration and other stakeholders should find a way of availing greenhouse materials to farmers locally and at subsidized prices.

6.In order to improve adoption of greenhouse technology by women and the youth this study also recommends that the Ministry of Gender and the Ministry of youth should come up with strategies of ensuring more participation of women and youth, for instance by making women and youth enterprise funds more accessible and affordable.

7. The farmers should put more effort in attending trainings when called upon and turn out in big numbers.

8.Men farmers should embrace gender issues related to greenhouse technology more positively by ensuring that women participate more or less equally when it comes to making decisions on adoption of greenhouse technology and on income from greenhouse farming since women contribute significantly particularly in the provision of labour.

9. Farmers should also encourage and support the youth to adopt greenhouse technology as a means of employment creation. Similarly farmers with greenhouses should form an association to increase their bargaining power in the marketing of the produce and for lobbying their issues with the Government.

10.The County Government of Nyeri in collaboration with Horticultural Crops Development Authority (HCDA) should have a cooling plant for horticultural Crops to ensure that there is proper storage of the horticultural crops as they await marketing and at the same time collaborate with local buyers and exporters of the horticultural products to make sure that there is good market of these produce since this strategy would act as a good incentive for the farmers to adopt greenhouse technology.

11. The County Government of Nyeri should also collaborate with investors to put up a factory for processing horticultural produce as a strategy of value adding the produce for improved market price. This strategy would also go a long way as incentive to farmers in increasing the rate of adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County.

## 5.6 Recommendations for Further Studies

There is limited information on greenhouse technology in Kenya thus further research is recommended since most of the studies reviewed during this study were conducted in other countries and few in Kenya. Specifically researcher suggests further research in these areas:

1. An investigation into low youth participation in greenhouse farming.
2. Assessment of impact of greenhouse technology on household food security.
3. Assessment of impact of greenhouse technology on employment creation.

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# APPENDICES

## APPENDIX 1: CONFIRMATION LETTER

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION
DEPARTMENT OF EXTRA MURAL STUDIES
P O Box 598 - NYERI : Tel : 061-2030460

3 July 2012

TO WHOM IT MAY CONCERN

SUBJECT : CONFIRMATION LETTER
ALICE WANGUI GICHUKI - REG. NO.L50/60684/2011

This is to confirm that the above named is a bona fide student of University of Nairobi pursuing a **Master of Arts Degree in Project Planning and Management** - in the **School of Continuing and Distance Education – Department of Extra Mural Studies.**

She has completed course work and is currently writing the **Research Project** which is a requirement for the award of the **Masters Degree.**

Her topic is ***"Factors Influencing Adoption of Green House Technology; Case of Gatitu Sub-Location in Nyeri Central District, Nyeri County".***

Any assistance accorded to her will be highly appreciated.

Dr. L. Otieno - Omutoko
RESIDENT LECTURER
NYERI & MT. KENYA REGION

## APPENDIX 2: INTRODUCTION LETTER

**ALICE W. GICHUKI**

**P.O. BOX 728,**

**NYERI**

**16TH MAY, 2012**

**DEAR RESPONDENTS,**

**RE: FILLING OF RESEARCH QUESTIONNAIRE**

I am a student at the University of Nairobi pursuing a Master of Arts Degree in Project Planning and Management. I am currently undertaking a research of factors influencing adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District, Nyeri County.

The questionnaires attached are meant for collecting information which will assist in the study. Kindly complete the questionnaires as honestly as possible. All the information you give will be held in utmost confidence and will not be used for any other purposes except for this study. Your positive response will be highly appreciated.

Yours sincerely,

**Alice Wangui Gichuki,**

**Researcher**

**Telephone: 0721633225**

## APPENDIX 3: QUESTIONNAIRE FOR FARMERS WITH GREENHOUSE(S)

This questionnaire is for the purposes of collecting research information relating to adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District.

All the information will be used for the purpose of the research only and will be treated with utmost confidence. Kindly respond to all the questions. Your cooperation will be highly appreciated.

**Instructions**

Kindly use tick (√) inside the box to indicate the correct answer where choices are given. Write your answer in the spaces provided where choices are not given.

**SECTION A**

**Demographic Data**

1. Gender

   Male ☐

   Female ☐

2. Age in years

   18 – 29 ☐

   30 - 39 ☐

   40 - 49 ☐

   50 - 59 ☐

   60 and above ☐

3. Indicate the highest educational level attained

Adult Education ☐

Primary ☐

Secondary ☐

Certificate ☐

Diploma ☐

Degree and above ☐

**SECTION B**

**Current Greenhouse Farming Practices**

4. What is the size of the farm?

Less than one acre ☐

One acre to 5 acres ☐

Above five acres ☐

1. How many greenhouses do you have?

One ☐

More than one ☐

6. What type of crops do you grow in your greenhouse?.....

7. If yes, for what purpose do you grow these crops?

For food ☐

For income generation ☐

For both food and income ☐

For self employment ☐

As a hobby ☐

8. To what extent do you feel that greenhouse technology contributes towards household food security?

| | |
|---|---|
| High | ☐ |
| Moderate | ☐ |
| Neutral | ☐ |
| Low | ☐ |
| Not at all | ☐ |

**SECTION C**

**Greenhouse Financing**

9. Which source amongst the ones listed below avails finances to help in financing greenhouse technology projects

| | |
|---|---|
| Savings | ☐ |
| Pension | ☐ |
| Salary | ☐ |
| Family | ☐ |
| Loan | ☐ |
| Others (Specify) | _____ |

10. In your opinion, how do you rate access to credit from the financial institutions?

| | |
|---|---|
| Extremely inaccessible | ☐ |
| Inaccessible | ☐ |
| Don't know | ☐ |
| Accessible | ☐ |
| Extremely accessible | ☐ |

11. Access to finance influences adoption of greenhouse technology?

| | |
|---|---|
| Strongly Agree | ☐ |
| Agree | ☐ |
| Neutral | ☐ |
| Disagree | ☐ |
| Strongly Disagree | ☐ |

**SECTION D**

**Knowledge on Greenhouse Technology**

12. Which source amongst the ones listed below avails knowledge on greenhouse technology to you?

| | |
|---|---|
| Other farmers | ☐ |
| Government agricultural officers | ☐ |
| Private extension providers | ☐ |
| Media | ☐ |
| Internet | ☐ |
| All of the above | ☐ |

13. In your opinion, to what extent do you rate access to knowledge on greenhouse technology?

| | |
|---|---|
| Extremely inaccessible | ☐ |
| Inaccessible | ☐ |
| Don't know | ☐ |
| Accessible | ☐ |
| Extremely accessible | ☐ |

14. Access to knowledge influences adoption of greenhouse technology.

Strongly Agree ☐

Agree ☐

Neutral ☐

Disagree ☐

Strongly Disagree ☐

15. In your opinion how should access to knowledge be improved to make more farmers adopt greenhouse technology?.....

**SECTION E**

**Availability of Greenhouse Materials**

16. Availability of greenhouse materials affect adoption of greenhouse technology.

Strongly Agree ☐

Agree ☐

Neutral ☐

Agree ☐

Strongly Disagree ☐

17. If you have a greenhouse, what type of materials have you used?

New ☐

Second hand ☐

18. Which source amongst these listed below do you get your greenhouse materials from?

Nyeri ☐

Nairobi ☐

Naivasha ☐

Others (specify) .....

19. To what extent would you rate access to greenhouse materials to you?

Extremely inaccessible ☐

Inaccessible ☐

Don't know ☐

Accessible ☐

Extremely accessible ☐

**SECTION F**

**Gender Issues on Adoption of Greenhouse Technology**

20. Who decided on establishment of a greenhouse within the farm?

Male ☐

Females ☐

Both ☐

21. Who owns the greenhouse within the farm?

Male ☐

Female ☐

Both ☐

22. Who takes care of the crops in a greenhouse?

Male ☐

Females ☐

Both ☐

23. Who controls the income from greenhouse?

Male ☐

Females ☐

Both ☐

24. Amongst the various gender categories given below, who would easily get the credit for greenhouse?

Male ☐

Females ☐

Both ☐

25. What other measures should be taken to improve adoption of greenhouse technology?

.....

**THANK YOU FOR YOUR COOPERATION AND ASSISTANCE**

## APPENDIX 4 : QUESTIONNAIRE FOR FARMERS WITHOUT GREENHOUSE(S)

This questionnaire is for the purposes of collecting research information relating to adoption of greenhouse technology in Gatitu Sub-Location in Nyeri Central District.

All the information will be used for the purpose of the research only and will be treated with utmost confidence. Kindly respond to all the questions. Your cooperation will be highly appreciated.

**Instructions**

Kindly use tick (√) inside the box to indicate the correct answer where choices are given. Write your answer in the spaces provided where choices are not given.

**SECTION A**

**Demographic Data**

1. Gender

   Male ☐

   Female ☐

2. Age in years

   18 – 29 ☐

   30 - 39 ☐

   40 - 49 ☐

   50 - 59 ☐

   60 and above ☐

3. Indicate the highest educational level attained

Adult Education ☐

Primary ☐

Secondary ☐

Certificate ☐

Diploma ☐

Degree and above ☐

**SECTION B**

**Current Greenhouse Farming Practices**

4. What is the size of the farm?

Less than one acre ☐

One acre to 5 acres ☐

Five acres and above ☐

5. From the choices given below where did you get information about greenhouse technology?

Other farmers ☐

Government agricultural extension officers ☐

Private extension providers ☐

Media ☐

Internet ☐

All of the above ☐

6. In your opinion, to what extent do you rate access to knowledge on greenhouse technology?

| | |
|---|---|
| Extremely inaccessible | ☐ |
| Inaccessible | ☐ |
| Don't know | ☐ |
| Accessible | ☐ |
| Extremely accessible | ☐ |

7. In your opinion, to what extent does knowledge influence adoption of greenhouse technology?

| | |
|---|---|
| Strongly Agree | ☐ |
| Agree | ☐ |
| Neutral | ☐ |
| Disagree | ☐ |
| Strongly Disagree | ☐ |

8. In your opinion how should access to knowledge be improved to make more farmers adopt greenhouse technology?

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**SECTION C**

**Greenhouse Financing**

9. Which source amongst the ones listed below would avail finances for adoption of greenhouse technology?

| | |
|---|---|
| Savings | ☐ |
| Pension | ☐ |
| Salary | ☐ |
| Family | ☐ |
| Loan | ☐ |
| Others (Specify) | _____ |

10. In your opinion, how do you rate access to credit from the financial institutions required for adoption of greenhouse technology?

| | |
|---|---|
| Extremely inaccessible | ☐ |
| Inaccessible | ☐ |
| Don't know | ☐ |
| Accessible | ☐ |
| Extremely accessible | ☐ |

11. How does access to finance influence adoption of greenhouse technology?

| | |
|---|---|
| Strongly Agree | ☐ |
| Agree | ☐ |
| Neutral | ☐ |
| Disagree | ☐ |
| Strongly Disagree | ☐ |

**SECTION D**

**Availability of Greenhouse Materials**

12. Which source amongst these listed below would you get your greenhouse materials from?

Nyeri ☐

Nairobi ☐

Naivasha ☐

Others (specify) .....

13. Availability of greenhouse materials affect adoption of greenhouse technology.

Strongly Agree ☐

Agree ☐

Neutral ☐

Disagree ☐

Strongly Disagree ☐

14. To what extent would you rate access to greenhouse materials to you?

Extremely inaccessible ☐

Inaccessible ☐

Don't know ☐

Accessible ☐

Extremely accessible ☐

**SECTION F**

**Gender Issues on Adoption of Greenhouse Technology**

15. In your opinion, whom would you think would decide on the adoption of greenhouse technology in your household?

Male ☐

Females ☐

Both ☐

16. In case you establish a greenhouse on your farm who would own it?

Male ☐

Female ☐

Both ☐

17. In your opinion, who would take care of the crops in the greenhouse?

Male ☐

Females ☐

Both ☐

18. In your opinion, who would control the income from the greenhouse?

Male ☐

Females ☐

Both ☐

19. Amongst the various gender categories given below, who would easily get the credit for greenhouse?

Male ☐

Females ☐

Both ☐

20. To what extent do you feel that greenhouse technology contributes towards household food security?

| | |
|---|---|
| High | ☐ |
| Moderate | ☐ |
| Don't know | ☐ |
| Low | ☐ |
| Not at all | ☐ |

21. What other measures should be taken to improve adoption of greenhouse technology?

.....

**THANK YOU FOR YOUR COOPERATION AND ASSISTANCE**

## APPENDIX 5: OBSERVATION GUIDE

| LEVEL OF TECHNOLOGY | FACILITIES AND EQUIPMENTS USED |
|---|---|
| Very High | Automated/computerized system for controlling environmental conditions, new covering materials, metal framework, drip irrigation, imported liquid planting media and complicated design. |
| High | System not automated, new covering material, metal framework, drip irrigation, imported solid media and complicated design. |
| Medium | New covering material, improved soil media, quality timber framework, improved soil media and drip irrigation. |
| Low | Second hand covering material, normal soil media, and use of water can for irrigation, and normal soil media. |
| Very low | Second hand covering material, normal soil media, and use of water can for irrigation, and normal soil media. |