THE INFLUENCE OF AGRICULTURAL TECHNOLOGIES ON FOOD SECURITY AMONG HOUSEHOLDS IN NAKURU DISTRICT, KENYA.

BY

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DECLARATION

This research project report is my original work and has not been presented for a degree or other award in any other University.

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DEDICATION

This research project report is dedicated to my beloved wife Jane Njoki and my son James Kanjeru for their prayers and support during this study.

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ABBREVIATIONS AND ACRONYMS

ASK	Agricultural Society of Kenya
DFID	Department for International Development
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GOK	Government of Kenya
IDB	Inter American Development Bank
IFAD	International Fund for Agricultural Development
IFOAM	International Federation of Organic Agriculture Movements
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IWMI	International Water Management Institute
KARI	Kenya Agricultural Research Institute
KEBS	Kenya Bureau of Standards
MOA	Ministry of Agriculture
NGO	Non Governmental Organization
POCTETA	Programme for Territorial Cooperation Spain-France-Andorra
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development.
UNEP	United Nation Environment Programme
USAID	United States Agency for International Development
WHO	World Health Organization

ABSTRACT

The Kenya Vision 2030 is a vehicle for accelerating transformation of Kenya into a rapidly Industrializing middle-income nation by the year 2030.The Vision 2030 recognizes the role of science, technology and innovation in a modern `economy, in which new knowledge plays a central role in wealth creation, social welfare and international competitiveness. It is reported that fifteen million (approx. 50 %) of Kenyans are food insecure with three million supplied with food relief throughout the year (Kaloi etal, 2005). As a result of this food security concern, the government and lead agencies in agricultural sector came up with agricultural technologies like indoor mushroom production, green house horticultural production, organic farming and plot based Jatropha production among others, in attempt to address this alarming problem. The study assessed the influence of agricultural technologies on food security among households in Lanet and Barut Divisions of Nakuru District. The objectives of the study were to assess indoor mushroom production and food security among households, determine influence of green house horticultural production and food security, assess influence of plot based Jatropha production and food security and finally assess influence of organic farming on food security among the households. The study was based on diffusion of innovation theory. The study used a descriptive survey design. The population of the study was 10,423 households. A sample of 212 respondents was considered with 200 households (145 households from Lanet Division and 55 households from Barut Division), 6 group leaders and 6 extension staff. This sample was picked using stratified random sampling and proportionate sampling. Questionnaires were used to collect data. Pilot testing was carried out in 10 households before the commencement of the study and errors in the data collection instruments were corrected. Data analysis was done using Statistical Package for Social Sciences and Ms Excel. Descriptive statistic was computed and data presented using tables. In the first objective, the study showed that 12 respondents practised indoor mushroom farming and produced 1909.5 Kilgrammes which generated 235,006 Kenya shillings. The consumption of mushroom is 1-200kgs per year which is low despite its high nutritive value. In the second objective, the study has shown that 21 respondents practised green house horticultural farming, produced 76,509 Kilogrammes worth 3,650,007 Kenya shillings. Majority of respondents (11) planted only tomatoes in their green houses. Lack of capital hindered 82 respondents from practicing green house horticultural production. In the third objective, the study has shown that plot based Jatropha production was practised by 10 respondents who produced 252.5 Kilogrammes of Jatropha seeds worth 7,502.5 Kenya shillings. In the fourth objective, the study showed that organic farming is practiced by 199 respondents and besides improving soil fertility, it generated 74,003 Kenya shillings from sales. Organic farming was ranked as the most important agricultural technology in the area of study. The study also showed that indoor mushroom production, green house horticultural production, plot based Jatropha production and organic farming influence food security status in the study area. These agricultural technologies produce food, income and act as a source of employment in the study area. The research findings generated information which will be used by farmers, government agencies and other stakeholders to understand agricultural technologies and their influence towards food security among households.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Globally, a total of 925 million people are still estimated to be undernourished in 2010, representing almost 16 percent of the population of developing countries
(Food and Agriculture Organisation, 2010).According to World Food Programme (1998),the number of recipients of food and other humanitarian assistance stands at 75 million people, yet the United Nations(UN) millennium development goal number one calls for halving the proportion of people who suffer from hunger between 1990 and 2015 (Mougeot,2005).
According to FAO (1997), approximately 70 percent of the population in sub-Saharan Africa lives in rural areas where crop production and animal production, fisheries and forestry activities are direct sources of food and provide income with which to buy food. Increased and diversified production of food for family consumption or as a source of income is a basic prerequisite for improved household food security.

According to Mbugua, et al. (2008), over 10 million people suffer from chronic food insecurity and poor nutrition, depicted by a high proportion of the population having no access to food in the right amounts and quality, and between two and four million people requires emergency food assistance at any given time. Nearly 30% of Kenya's children are classified as undernourished, and micronutrient deficiencies are widespread (MOA, 2011).
Kenya Agricultural Research Institute (2010),noted that the current food insecurity problems in Kenya are attributed to several factors, including the frequent droughts in most parts of the country, high costs of domestic food production due to high costs of inputs especially fertilizer, displacement of a large number of farmers in the high potential agricultural areas following the post-election violence which occurred in early 2008, high global food prices and low purchasing power for large proportion of the population due to high level of poverty. According to FAO (1997), household food security depends on an adequate income and assets, including land and other productive resources owned. Food security is ultimately associated with access to nutritionally adequate food at household level, that is the ability of households or individuals to acquire a nutritionally adequate diet at all times.

According to Valero (2010), Technology is key tool to use especially in disseminating information to farmers. Furthermore, adoption of technology by farmers increases food production and food security thereby contributing to national goal of improved livelihoods of Kenyans. The need for community based and participatory approaches to technology generation and dissemination is now widely acknowledged. The best farm yields can be obtained through integrated approach using better seeds, water efficient technologies, nutrients, pest and weed management and soil conservation. Igbedioh (1990),stated that farmers initiatives and new technologies that increase production and employment in agricultural sector including the establishment of small and medium scale food processing facilities can help augment incomes, alleviate poverty and improve food security. In an attempt to achieve household food security, recent agricultural technologies like organic farming, mushroom production, green house horticultural production, Jatropha production among others have been released by researchers, field trials carried out and demonstrations done by farmers with positive impact on improving household food security. According to Ministry of Agriculture (2007), Vision 2030 recognises the role of science, technology and innovation in a modern `economy, in which new knowledge plays a central role in wealth creation, social welfare and international competitiveness.

Unsworth (2010) reported that vulnerable groups, such as the very poor, women and marginalised communities can often lack the skills and confidence to engage in community decision-making. It may therefore be important to support mechanisms designed to specifically target marginalised groups in order to ensure that they can participate. It is argued that participation in local associations can empower poor people to engage in public politics and collective action. Food and Agriculture Organisation (2008) reported that improving agricultural sustainability through adoption of organic farming in Africa may not be a solution to all the food problems but a considerable progress has been made in recent years. According to International Federation of Organic Agriculture Movements(IFOAM,2012), increasing number of farmers, NGOs, politicians and development experts have realized that instead of the capital and chemical input intensive approach, we should favour an organic agriculture that emphasizes bio-diversity, recycling of nutrients, synergy among crops, animals, soils, and other biological components, as well as regeneration and conservation of resources. According to Kimemia and Oyare (2006),the organic produce in Kenya are french beans, cotton, runner beans, salads, hibiscus tea, jam, macadamia and other nuts. In Nakuru District, Lanet and Barut Divisions included, organic farming is practised both fully and partially (some inorganic fertilizers applied) in the production

of cereals, pulses, fruits and vegetables. Organic farming has saved the farmers the cost of purchasing inorganic fertilizers and other chemicals which are very expensive and sometimes not available.

World production of mushrooms (mushroom production technology) is estimated at 12 million tonnes with China taking the lead and producing 86.6% of the world production (Chang, 2004). In Kenya, mushroom cultivation is a recent introduction (1970), but the production is slowly and steadily picking up. Kenya's annual production is estimated at 500 tonnes with a farm gate value of 225 million shillings and retail value of 340 million shillings (FAO, 2010). The bulk of this production comes from large scale farms which constitutes 90-95% of the total production. The major commercial mushroom producers in Kenya are Agridutt Kenya Ltd (35%), Rift Valley Mushrooms (30%), Olive Farm (20%) and Devan (10%). Small scale production is taking place in Rift Valley, but concentrated mainly in Nyanza, Western and Coast provinces. According to Gateri (2012), Mushroom cultivation can directly improve livelihoods through income generation, food security and better health. There are several opportunities along the mushroom value chain that can be exploited thereby creating employment for several people. They have the potential to boost the overall national economy, thus helping the country achieve the 10% GDP growth. There is very high demand for mushrooms especially the button type. Kenya produces 500 tons per annum (of which 476 tons being button) against an annual demand of 1200 tons both in hotels and home consumption (MOA, 2012). Mushroom farming is practised in Nakuru District. For instance, Balm of Hope Self Help group in Lanet Division was supported by Njaa Marufu Funds to expand mushroom farming and currently it is producing 100 Kilogrammes of processed mushroom per month and then sells to individuals, hotels and restaurants in Nakuru District and its neighbors. Balm of Hope Self Help group is registered with Kenya Bureau of standards (KEBS) and has recruited five (5) out growers (MOA, 2011).

According to Jomo Kenyatta University Agriculture and Technology (2013), the ever increasing population poses a great challenge to production of adequate food and materials with available land and other natural resources. The situation is exacerbated by occasional adverse weather phenomena such as drought and extreme conditions which damage crops, resulting in low agricultural yields and low products quality. Protected production within green houses (green house horticultural production technology) offers means of increasing productivity through improved water use efficiency, reduce the incidence of pests and enhance production of a range

of horticultural crops. The Most popular food crops grown in greenhouses are tomato ,cucumber, and sweet pepper while greenhouse grown vegetables include watermelon, lettuce, eggplant, snap beans, celery, cabbage, radish, onion, and asparagus and Fruits such as grapes, strawberry, banana, pineapple, papaya, orange, mandarin, cherry, and medicinal herbs. According MOA (2011), green houses in Lanet and Barut Divisions are mainly for tomato production. It takes a shorter period two months for greenhouse produced tomatoes to mature, while it takes a minimum of three months with outdoor farming.

According to Moraa et al. (2009), *Jatropha curcas* has been planted as hedges for demarcation for fields in some parts of Kenya. However, for the past few years, Jatropha has been widely promoted by NGOs or private companies to be adopted by smallholder farmers across diverse agro climatic conditions for the purpose of biodiesel production. Tomomatsu and Swallow (2007) made a preliminary assessment of market feasibility of Jatropha based biodiesel production chain and its profitability to small scale farmers in Kenyan context and concluded that Jatropha is not a viable feedstock at the present. It was reported that the major constraints identified are uncertainty over productivity due to lack of agronomy knowledge and lack of markets. If measures to enhance its productivity are taken, Jatropha could have a potential to serve as a biodiesel feedstock.

Modern agricultural technologies adoption and implementation faces many challenges. According to Agricultural Society of Kenya (2011), there is limited access to extension services in most parts of the country with the National extension staff to farmer ratio standing at 1:1,500, inadequate research extension farmer linkages to facilitate demand driven research and increased use of improved technologies continue to constrain efforts to increase agricultural productivity as farmers continue to use outdated and ineffective technologies. This situation has hindered most farmers from keeping pace with changing technological advances. In Lanet and Barut Divisions, extension staff to farmer ratio is at 1:800. Therefore, there is a need for recruitment of more extension staff and the involvement of Non Governmental Organisation's to increase access of extension services farmers. Jack (2011) observed that an indigenous system for generating technical change is necessary if the technology is to match changing local needs. Inadequate community participation, high level of poverty, cultural issues, poor infrastructure and marketing problems may also be some of the other challenges faced by farmers while implementing modern agricultural technologies in the study area (Mukisira, 2008).

1.2 Statement of the Problem

According to Kaloi et al. (2005), Fifteen million (approx. 50 %) of Kenyans are food insecure with 3 million supplied with food relief throughout the year. Due to this food security concern, the government and lead agencies in agricultural sector have come up with a number of agricultural technologies like indoor mushroom production, green house horticultural production, organic farming and plot based Jatropha production for biodiesel extraction (*Jatropha curcas*) among others, in attempt to address this alarming problem. Lanet and Barut Divisions was one of the recipients of post election victims. This compounded the problem of food insecurity. These agricultural technologies have been experimented, demonstrated and adopted by farmers with positive impact on food security.

Kipkoech (2011),indicated that to boost food security and bridge the gap between vision 2030 blue print target and agricultural projects on the ground, technology has to be applied from the farm through to processing, storage and marketing which also requires the implementation of the right policies, finances, insurances, infrastructures and information. Results from various studies on these agricultural technologies vary from household to household and from area to area.

However, it has not been empirically reported on the contribution of these technologies on food security. This study therefore intended to assess the influence of agricultural technologies on food security among households in Lanet and Barut Divisions of Nakuru District. This formed the basis of this study.

1.3 Purpose of the Study

The purpose of this study was focused on the influence of agricultural technologies on food security among households in Lanet and Barut Divisions of Nakuru District.

1.4 Research Objectives

This study was guided by the following objectives:

1. To assess how indoor mushroom production influence food security among households in Lanet and Barut Divisions, Nakuru District.
2. To determine how green house horticultural production influence food security among households in Lanet and Barut Divisions, Nakuru District.
3. To assess how plot based Jatropha production influence food security among households in Lanet and Barut Divisions of Nakuru District.

4. To assess how organic farming influence food security among households in Lanet and Barut Divisions of Nakuru District

1.5 Research Questions

This study was guided by the following research questions:

1. How does indoor mushroom production influence food security among households in Lanet and Barut Divisions of Nakuru District?
2. How does green house horticultural production influence food security among households?
3. To what extent does plot based Jatropha influence food security among households?
4. To what extent does organic farming influence food security among households?

1.6 Justification of the Study

Whereas it could not be denied that the government had taken measures to boost food security, the food insecurity situation of Lanet and Barut Divisions had been an issue of major concern. According to FAO (1997), approximately 70 percent of the population in sub-Saharan Africa lives in rural areas, where crop production and animal production, fisheries and forestry activities are direct sources of food and provide income with which to buy food. Therefore, increased and diversified production of food for family consumption or as a source of income is a basic prerequisite for improved household food security. This has forced the farmers and other players in food security to explore agricultural technologies like indoor mushroom production, organic farming, green house horticultural production and plot based Jatropha production technologies with an intention of improving food productivity and food security. It is on the basis of this premise that the study was initiated with an aim of establishing the assessing agricultural technologies influencing food security among households in Lanet and Barut Divisions.

1.7 Limitations of the Study

A descriptive survey design lack control over a long time frame and sometimes lead to low response rates. To avoid this limitation, the questionnaires were in most cases administered, filled and picked the same day. In cases where the right respondents were not available, the questionnaires were left and picked after two days.

Some respondents had low Literacy level and this hindered articulation of questions which were written in English. When this occurred, translators were engaged.

1.8 Delimitations of the Study

The study covered Lanet and Barut Divisions of Nakuru District. The study focused on farmers practicing agricultural technologies namely indoor mushroom production, organic farming, green house horticultural production and plot based Jatropha production. The study used descriptive survey design because the researcher looked at the phenomena, events and issues the way they were. Stratified random sampling and proportionate sampling were used. This study covered a population of 10,423 households with 7566 households from Lanet Division and 2857 households from Barut Division. Questionnaires were filled by 212 respondents (200 households from 10,423 households, 6 extension staffs and 6 group leaders).The sample was composed of adult male, adult female and youth farmers. The study used questionnaires because a large population was targeted for data collection. The study was carried out in the months of May which was dry and enabled accessibility to all parts of the Divisions.

Studies have shown that food Producing households are less vulnerable to economic crisis and increases in food prices than non-producing households (Veenhuizen, 2012).This study looked at the assessment of agricultural technologies on food security among households in Lanet and Barut Divisions, Nakuru District. The agricultural technologies considered in this study were indoor mushroom production, green house horticultural production, plot based Jatropha production and organic farming.

1.9 Significance of the Study

The information obtained from the study is useful to farmers, government departments and other stakeholders in various ways. They will be able to understand agricultural technologies and their influence on food security among households. Policy makers will be able to plan strategies which will bring development in the area based on findings of the study. The extension agents will be empowered to train and educate the farmers to understand agricultural technologies which can be carried out to improve food security among households.

1.10 Definition of Significant Terms

Challenge Problems experienced when disseminating, adopting and implementing agricultural technologies.

Extension service Refers to provision of technical advice offered to farmers by extension staff and other service providers to improve farm productivity

Farmers' empowerment These are the supports provided to farmers practicing agricultural technologies. In this study farmer empowerment will mean capital support in terms of farm inputs and farmers trainings.

Food security This is ability to have sufficient food throughout the year. This may also refers having an income which can purchase the required food stuffs. In Lanet and Barut Divisions, a household of six persons requires six bags of maize (Ksh.2500 per bag) and two bags (Ksh.4000 per bag).So besides Mushroom and horticultural produce being used as food, they generate income which can be used to purchase staple food.

Household This is a group of individuals who eat together and live together, performing and sharing most domestic responsibilities as a means of survival (El-Bushra, 1993).According to this study, household refers to members of the nuclear family and their dependants who live and eat together in the same house.

Agricultural Technologies Refer to agricultural initiatives undertaken to improve farm productivity. In this study the technologies will be indoor mushroom production, green house horticultural production, Jatropha production and organic farming.

1.11 Organisation of the Study

Chapter one covers the background of the study, statement of the problem and purpose of the study. This is followed by setting up of research objectives and research questions. This is then followed by justification of the study, limitations and delimitations, significance of the study and definition of significant terms and concludes with the organization of the study.

Chapter two covers literature review from various sources to establish work done by other researchers, their findings, conclusions and identification of knowledge gaps which forms the basis of setting objectives and research questions of the study. The theoretical and conceptual frameworks are also explained.

Chapter three covers the research design, target population of the study, sample size and sampling procedures. This is followed by data collection procedures, data collection instruments, validity of instruments, reliability of instrument, data analysis techniques, ethical considerations and concludes with operational definition of variables.

Chapter four covers findings from data analysis, presentation of findings and interpretation of findings. It is concluded with summary of the chapter.

Chapter five covers summary of findings, discussion, conclusions and recommendations of the study. It is concluded with suggested areas for further research and contribution to the body of knowledge.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covered literature that is relevant to the study. This included global food security status, food security status in Kenya, food security status in Nakuru District, agricultural technologies and food production in Kenya, role of technology in enhancing food security, farmers' empowerment, marketing of farm produce and food security and challenges faced through adoption of agricultural technologies. This chapter also included theoretical framework and conceptual framework.

2.2 Global Food Security Status

Nyassy (2007) projected that the World population will increase from 6 billion to 9 billion by 2050, thus increasing the need for more food. According to United Nations Environment Programme (2007), each day 200,000 more people are added to the world food demand. These people will need housing, food and other natural resources. According to FAO (2010), the number and proportion of undernourished people in developing countries is 870 million people. This number is unacceptably high. In Africa, the number of undernourished people in the African continent has steadily increased since the early 1990s from 175 million to 239 million today. FAO (2010) has also shown that 36 countries in the world require external food assistance. From the 36 countries requiring external food assistance, 28 countries come from African countries. These include countries which are large net importers of cereals and fuels, with generally low per capita incomes, relatively high levels of malnutrition, and for which there is a strong transmission of high international food prices.

In Lanet Division, food security is linked to the consumption, production, and marketing of food, the functioning of factor markets especially for labor social safety nets, governmental and nongovernmental assistance agencies, initial asset and income distributions, and myriad other subjects across several disciplines (Barret,2002). Reports during FAO(2008) indicated that household and national food security are complex and complicated goals influenced by many factors such as technologies, human capacities, policies, prices, trade and infrastructural context. Demand for food is certain to increase with increasing population pressure and income, even though this demand and ability to supply the demand are not equal in all communities. Indeed,

today's total global agricultural production is sufficient to feed the current world population and both necessary technologies and multilateral environmental agreements are available to help meet development and conservation needs. However, hunger, poverty and environmental degradation persist even as concerns about global human security issues continue to increase.

According to United Nations Development Programme (1997), sustainable productivity growth can come only from pushing on the frontier of agricultural science and technology and that comes only from continuous research and adaptation. Putting integrated solutions in the hands of the growers can enhance yields, improve incomes and protect natural resources. This in turn helps to break the cycle of poverty and hunger which inflicts rural communities' worldwide. Therefore technology is the key tool to use especially in disseminating information to farmers; this is because adoption to technology by farmers will significantly increase food security and production thereby contributing to the national goal of improved livelihood of world population.

According to World Bank (2013), it indicated that Africa's farmers and agribusinesses could create a trillion-dollar food market by 2030 if they can expand their access to more capital, electricity, better technology and irrigated land to grow high-value nutritious foods. The report calls on governments to work side-by-side with agribusinesses, to link farmers with consumers in an increasingly urbanized Africa. Gill (2002) concluded that some technologies may promote increased production thus boosting national level of food availability but at the same time reducing the labourers bargaining power and thus increasing poverty and reducing household level food access for one of the poorest groups in the community. This called for a study to assess the influence of agricultural technologies on food security among households.

2.3 Food Security status in Kenya

According to Government of Kenya (2011), half of Kenya's estimated 38.5 million people are poor, and some 7.5 million people live in extreme poverty while over 10 million people suffer from chronic food insecurity and poor nutrition. It is estimated that at one time about two million people require assistance to access food. During periods of drought, heavy rains and during floods the number of people in need of food could double. KARI (2010) pointed out that the current food insecurity are attributed to frequent drought in most parts of the country, high costs of domestic inputs, displacement of farmers from high potential agricultural areas following the

post election violence which occurred in early 2008, high global prices and low purchasing power for large proportion of the population due to high level of poverty.

However, Kipkoech (2011),stated that to boost food security and bridge the gap between vision 2030 blue print target and agricultural projects on the ground, technology has to be applied from the farm through to processing ,storage and marketing and it requires the implementation of the right policies, finances, insurances ,infrastructures and information. Johnson (2013) stated that in order to feed a population of nine billions in 2050, it calls for production of more food with fewer resources. This can be achieved through collaboration, investment and innovation among all stakeholders. Valero (2013) reported that technology is the key tool to use especially in disseminating information to farmers. He further said that adoption of technology by farmers will significantly increase food security and production thereby contributing to the national goal of improved livelihood of Kenyans. To feed people in Lanet Division, various agricultural technologies like indoor mushroom production, green house horticultural production, plot based Jatropha production and organic farming have been implemented.

Kipkoech (2011) also noted that with adequate food supplies in the country, the cost of living will be manageable and Kenyans will be able to invest the resources from their farming activities in other productive sectors of the economy. The study intended to assess the influence of agricultural technologies on food security among households in Lanet and Barut Divisions, Nakuru District.

2.4 Food Security Status in Nakuru District

According to MOA (2012), Nakuru District is one of the nine districts in Nakuru County. It has an area of 297.2 km^2 (Which include Lake Nakuru National Park) and a population of 308,783 persons. The District has three Divisions namely Municipality, Barut and Lanet. The study will cover Lanet and Barut Divisions. Barut Division has a population of 15,737 persons, 3457 households with 2857 practising farming. Lanet Division has a total population of 63,854 persons, 19,097 households and 7566 households practising farming, as shown in Table 2.1.

Table 2.1 Population and households of Lanet and Barut Divisions

Division	Location	Population	Number of households	Households practicing farming
Lanet	Free Area	49,045	14,322	5,675
Lanet	Lanet	14,809	4,775	1891
Barut	Kapkuress	8956	1967	1625
Barut	Barut	6781	1490	1232
Total		79,591	22,554	10,423

Source: Nakuru District achievement and progress review report of 2011

The rainfall regime is bimodal (760-1270mm per annum). The soil type is mainly volcanic. Nakuru District has an average attitude of between 1520m to 2400m above sea level. The agro ecological zones are UM3 (covers areas around Lanet), UM4 (Covers Municipality) and UM5 (covers mainly Barut division).The temperatures range from 20^{o}C to 26^{o}C (GOK, 2012).

The Government of Kenya report of 2008 indicated that Nakuru District has an average small scale farm size of 2.5 acres and 20 acres for large scale farmers. It further stated that the main crops grown in the district include maize, beans, Irish potatoes, wheat, fresh fruits, tomatoes (in green houses), and mushroom, indigenous and exotic vegetables while main livestock enterprises include dairy cattle, beef cattle, shoats poultry, pigs, rabbits, and bee keeping (GOK, 2008). According to MOA (2012), 18,566 persons out 309,424 persons in Nakuru District are food insecure, with Lanet Division having 4348 persons out of 63854 persons food insecure. Within the period farmers diversified their food production and also cash generated from the food sales used to purchase food stuffs from the market.

According to Burney et al. (2010), households becoming strong net producers in vegetables, with extra income earned from sales significantly increasing their purchases of cereals, pulses and protein and oils during rainy season. Rockwool foundation (2009) indicated that more than three quarters of the poor and hungry in Sub-Saharan Africa reside in rural areas and depend on agriculture for their living. In general agricultural production is lowest and poverty rates highest where the soils are poor and the rainfall is low and erratic. Population pressure is increasingly

forcing people to settle in rural areas and marginal lands and these areas are largely ignored and low prioritized by African governments. However, Valero (2010) pointed out that farmers in the rural areas need to achieve sustainable increases in productivity but are hindered by lack of infrastructure, access to markets, and modern technologies. Therefore Investments in agricultural and rural development is of great important. This study therefore assessed the influence of agricultural technologies namely indoor mushroom production, green house horticultural production, plot based Jatropha production and organic farming on food security among households.

2.5 Agricultural technologies and food production in Kenya

FAO World food summit (1996) reported that in marginal areas, appropriate agricultural technologies can go a long way towards stabilizing food availability and facilitating food access for the poor. Hazell and Haddad (2001) reported that until recently researchers and policy makers saw poverty alleviation as a subsidiary goal of agricultural research. The primary goal was to increase food supplies through cost reduction technological changes that would lead to a lower food price. They pointed further that agricultural growth has not only improved income distribution but also raising per capita incomes across the board. It has significantly contributed to reducing the numbers living below poverty line. Hazell and Haddad also pointed out that technologically driven agricultural growth can benefit poor people through increased own farm production for own consumption and for market thus getting farm income and thus gaining greater agricultural employment opportunities. They further said that poor farmers will obtain own farm benefits from new technologies only if they adopt them. This means that the new technologies must be appropriate and profitable for farming conditions and the poor farmers must have access to the knowledge and inputs necessary to adopt the technology. Farmers who adopt new technology often succeed in lowering their production costs per unit of output.

Dick et al. (2003), in their study pointed out that the primary goal of agricultural research was clear cut increase in food supply and reduction in cost of food especially staple crops such as wheat, rice and maize. In such cases high output was accompanied by increased agricultural employment, lower food prices, more off farm employment and a general reduction in food poverty. However, Mukisira (2008) reported that some of the constraints to technology adoption and up scaling are inadequate community participation, high level of poverty, cultural issues, poor infrastructure, marketing problems and inappropriate mechanization. He further pointed out

that with more than 25 million mobile users in Kenya and more than 75% of the entire 39 million Kenyans living in rural areas, mobile phones becomes an important bridge to get rural communities (small-scale farmers) connected. These help them to know the prices of food, the best agricultural practices to use, rapid response on disease outbreaks and what to do to contain the diseases, where they can sell their produce and get cheap inputs. According to UNDP (2012), sustainable productivity growth can come only from pushing on the frontier of agricultural science and technology and that comes only from continuous research and adaptation.

Gill (2002) stated that putting integrated solutions in the hands of the farmers can enhance yields, improve incomes and protect natural resources. This in turn helps to break the cycle of poverty and hunger which inflicts rural communities' worldwide. However, it is worth noting that some technologies may promote increased production thus boosting national level of food availability but at the same time reducing the labourers bargaining power and thus increasing poverty and reducing household level food access for one of the poorest groups in the community. There was therefore a need to carry out a study to assess the influence of agricultural technologies on food security among households.

2.5.1 Indoor Mushroom Production and Food Security

World production of mushroom is estimated at 12 million tonnes with China taking the lead and producing 86.6% of the world production (Chang, 2004). In Kenya, mushroom cultivation is a recent introduction (1970), but the production is slowly and steadily picking. According to the Ministry of Agriculture, Kenya produces 500 tons per annum (of which 476 tons being button) against an annual demand of 1200 tons both in hotels and home consumption. Mushroom breeds by utilizing nutrients from the substrate through colonizing the substrate and forms pinheads which then develop into fruit bodies (mushroom). Mushroom breeding requires right type of spawn (mushroom seeds) that is correct age and vibrant growing, substrate and right environment for maximum productivity. The seeds (spawns) are available in four types of carrier materials namely grain spawn, sawdust spawn, plug spawn and liquid spawn. Production varies depending on various factors like economic capacity and climatic conditions. Mushroom production methods include:-Trays, logs, Bags, bottles, Shelf-frame (shelve with bags), wall mat and saw dust blocks. Mushroom production can be practised indoor (inside houses) or outdoor. Studies have also indicated that the bulk of Kenya production of 500 tonnes per annum come from large scale farms which constitutes 90-95% of the total production. The major commercial

mushroom producers in Kenya are Agridutt Kenya Ltd (35%), Rift Valley Mushrooms (30%), Olive Farm (20%) and Devan (10%). Small scale production is also taking place in Rift Valley but mainly concentrated in Nyanza, Western and Coast provinces. Edible mushrooms can be used as a weapon against starvation because of its high protein and vitamin content. This contributes to food security by being easily available, affordable and usable.

According to Ministry of Agriculture (2011), mushroom farming is currently practised in Nakuru District. For instance, Balm of Hope Self Help group in Lanet Division was supported by Njaa Marufuku funds to expand mushroom farming and currently it is producing 100 Kilogrammes of processed mushroom per month and then sells to individuals, hotels and restaurants in Nakuru District and its neighbors. Balm of Hope Self Help group is registered with Kenya Bureau of standards (KEBS) and has recruited five (5) out growers. According to Ministry of Agriculture (2012), Kenya produces 500 tons per annum against an annual demand of 1200 tons both in hotels and home consumption. It imports 80,000 tonnes to satisfy its tourist industry. This indicates that there is a great potential of mushroom production since there is great demand both locally and internationally. United Nation Development Programme report (2012) indicated that a small field which usually produces a few vegetables every month, can provide a household with enough mushrooms for food and revenues weekly for instance in $1m^2$ a family can harvest 75 Kg of mushrooms every 1 or 2 weeks. However, mushroom production is still low in Kenya. This study looked into the influence of indoor mushroom to food security in the study area.

2.5.2 Green House Horticultural Production and Food Security

According to Gimmillaro (2012), Greenhouse framing is a new and exciting technology in Kenya. Green houses enable farmers to control the climate of their crops, preventing the damaging effects of drought, flood, and other extreme weather conditions. Kagwa (2012) who indicated that faced with reduced acreage for farming due to population growth and unpredictable weather conditions, many Kenyans are turning to greenhouse farming technology as a way to increase food production and supplement their income.

Jomo Kenyatta University Agriculture and Technology (2013), noted that the ever increasing population poses a great challenge to production of adequate food and materials with available land and other natural resources. The situation is exacerbated by occasional adverse weather phenomena such as drought and extreme conditions which damage crops, resulting in low

agricultural yields and produce quality. Protected production within greenhouses offers a means of increasing productivity by addressing these challenges. Though originally employed in temperate regions in order to extend the growing season, greenhouses have recently been introduced in tropical regions to improve water use efficiency, reduce the incidence of pests and enhance production of a range of horticultural crops.

Engelman (2011) advised that with global population at 7 billion, we need a swift transformation of energy, water, and materials consumption through conservation, efficiency, and green technologies. Ministry of Agriculture (2011),reported that although greenhouses have been in existence since 1800 (or earlier), and greenhouse food production started to develop as an industry in the second half of the nineteenth century, the largest growth and expansion of the greenhouse industry occurred throughout the world following World War II. Today, food production in greenhouses can be found in all continents. Most popular food crops grown in greenhouses are tomato (beefsteak, cluster, Italian, cherry), cucumber, and sweet pepper. Other greenhouse grown vegetables include watermelon, lettuce, eggplant, snap beans, celery, cabbage, radish, onion, and asparagus. Fruits such as strawberry, banana, pineapple, papaya, orange, cherry, and fig, as well as culinary and medicinal herbs, are also grown in greenhouses.

According to the Kenya Horticultural Development Project (greenhouse tomato project), one of the activities the programme is supporting to help increase the incomes of rural households is borrowed from Israel, where the country has most of its agriculture under greenhouses due to scarcity of water and land. It is also widely practised in the United States. It was therefore necessary to study how green house horticultural production contributes to food security.

2.5.3 Organic Farming and Food Security

International Federation of Organic Agriculture Movements (2000) pointed out that, organic agriculture includes all agricultural systems that promote the environmentally, socially and economically sound production of food and fibres. These systems take local soil fertility as a key to successful production. By respecting the natural capacity of plants, animals and the landscape, it aims to optimise quality in all aspects of agriculture and the environment. Organic agriculture dramatically reduces external inputs by refraining from the use of chemo-synthetic fertilisers, pesticides, and pharmaceuticals. Instead it allows the powerful laws of nature to increase both agricultural yields and disease resistance. Organic agriculture adheres to globally accepted principles, which are implemented within local social-economic, climatic and cultural settings.

Pimentel, Hepperly, Hanson, Seidel and Douds (2005) stated that organic agriculture seeks to augment ecological processes that foster plant nutrition while conserving soil and water resources. Organic systems eliminate agrichemicals and reduce other external inputs to improve the environment as well as farm economics.

International Federation of Organic Agriculture Movements (2012) reported that in Africa, there were 1.08 million hectares of certified organic agricultural land in 2010 with 550,000 producers. This constitutes about three percent of the world's organic agricultural land. The countries with the most organic land are Uganda with 228,419 hectares, Tunisia with 175,066 hectares and Ethiopia with 137,196 hectares. The majority of certified organic produce in Africa is destined for export markets but the European Union is the major recipient of these exports Grandi (2012) reported that, organic farming is well recognized for its contribution to improving food security and alleviating poverty, proactively creating new local and export markets, and driving sustainable rural development through the empowerment of farmers and their organizations. Organic production systems are particularly suitable to smallholder farmers as these systems depend on the sustainable use of local resources and on farmers' traditional knowledge and social networks. The shift to organic farming also offers health benefits for consumers and contributes to biodiversity conservation and climate change mitigation.

However, according to Wambua (2012), combined use of technologies reaps maximum benefits like the use of green manure and careful cultivation. Green manure supplies the soil with the nutrients. A farmer can plough back crop residues like bean pods or maize stocks into the soil. Practices such as crop rotation allow for nutrients to replenish. Composting which is allowing plant and animal residues to rot then added into the soils not only improves soil nutrients; it improves soil structure. He further said that Organic farming increases soil fertility, controls pests and diseases, saves environment from chemical deposits, makes ground water clean and safe, saves the farmer on money that would have been used on buy expensive farm inputs such as fertilizer. He also produces safe and nutritious foods that fetch better prices in the market.

According to Smallwood (2012), Organic methods can produce harvests 180 percent larger than chemical farming in communities that struggle to feed themselves. He further said that we could double food production in just 10 years using organic practices and other agro ecological farming methods. Organic farming creates more of the resources on which our food supply relies, while conventional farming destroys them. Conventional farming leeches nutrients from the soil, puts a

strain on our water supplies, and relies heavily on fossil fuels to make it work; organic farming builds better, more self-sufficient land, creates cleaner water, recycles nutrients, and leaves us with a cleaner atmosphere. However, many researchers have argued that organic farming produce lower yields than conventional farming. This is supported by findings of Wambua (2012) who stated that organic farming increases soil fertility, controls pests and diseases, saves our environment from chemical deposits, makes our ground water clean and safe, and saves the farmer on money that would have been used on expensive farm inputs such as fertilizer. He also indicated that organic farming produces safe and nutritious foods that fetch better prices in the market. Organic manure improves the livelihoods of small-scale farmers involved in organic farming. Organic food products are in high demand and there already exist organic farmers' markets. The foods sell at good prices and farmers can increase their incomes by simply taking on organic farming.

Prabu (2010) who reported that continued use of manures builds organic matter in soils and improves soil structure. This modification of soil structure helps improve water holding capacity, aeration, friability, and drainage. In addition, many trace nutrients needed for optimum plant growth are available from manures. Plant nutrients are also released more slowly and over a longer period of time than from most commercial fertilizers. Therefore organic farming influence food security of the study area. The study assessed the influence of organic farming on food security in the study area.

2.5.4 Plot based Jatropha (*Jatropha curcas*) Production and Food Security

Moraa et al. (2009) reported that *Jatropha curcas* is a small tree or shrub of Euphorbiaceae family. It is a perennial plant with a lifespan of 50 years and more when established from seed and 15 years or less when established from cuttings. It is believed to have originated from Central America, Caribbean or Mexico but has become naturalized in many tropical and subtropical areas like India, Africa and North America. It has been spread as a valuable hedge as well as a medicinal plant to Africa and Asian countries. According to Tomomatsu and Swallow (2007) production of Jatropha curcas has been widely promoted by private enterprises, nongovernmental organizations and development agencies as one of the most viable candidates for biodiesel feedstock in Africa. They further stated that while multiple benefits of jatropha production such as a petroleum product substitute, greenhouse gas mitigation and rural development are emphasized, the viability of production at farm level is questioned.

Moraa et al. (2009) reported that Jatropha plant is widely viewed as a potential biodiesel feedstock that is capable of growing in marginal areas where other crops cannot yield satisfactorily. However, wide adoption of the plant into farmers' plots by replacing existing food crops is perceived as a potential threat to food security. However, they pointed out that the most common uses of Jatropha include fencing, cow's shelter, income generation and soil conservation. When planted as a cow shelter the plant does not require application of fertilizer or manure. The plants under such use are healthier and produce more seeds per tree in relation to those planted as fence or income generation. With the escalating prices of fuel in Kenya, it was therefore necessary to assess the influence of plot based Jatropha on food security among households in Lanet and Barut Divisions.

2.6 Role of Technology in Enhancing Food Security

According to Ministry of Agriculture (2007), Vision 2030 recognises the role of science, technology and innovation in a modern `economy, in which new knowledge plays a central role in wealth creation, social welfare and international competitiveness.

According to Beye (2002), Agricultural research has played a crucial role in food security and agricultural development by increasing agricultural production to meet the food needs of a rapidly growing population. The green revolution of the 1960s and 1970s can be considered a yardstick of this impact. Notwithstanding the achievements, the challenges of feeding 8.3 billion people by the year 2025, remains great. More than ever, science-based agricultural technologies, developed through agricultural research, are essential to increasing productivity while maintaining or, better, improving the sustainability of natural resources and the environment.

Food and Agriculture Organisation (2010), reported that modern technologies and advances in the agricultural sector, such as inorganic fertilizer, pesticides, feeds, supplements, high yielding varieties, and land management and irrigation techniques have considerably increased production. This has been fundamental in meeting the food needs of a growing population and in generating economic growth needed for poverty reduction. However in certain circumstances these practices and techniques have caused ecological damage, degradation of soils, unsuitable use of resources, outbreak of pests and diseases and have caused health problems to both livestock and humans. Such unsustainable practices have resulted in lower yields, degraded or depleted natural resources and have a driver of agriculture's encroachment into important natural ecological areas such as forests. The quest to increase the yields and to do this without expanding the amount of land under cultivation has often heightened the vulnerability of production

systems to stocks such as outbreaks of pests and diseases, drought and floods and changing climatic patterns. In addition, there are many production systems in developing countries that due to a lack of finance, resources, knowledge and capacity are well below the potential yield that could be achieved.

In 2011, Government of Kenya indicated that about half of Kenya's estimated 38.5 million people are poor, and some 7.5 million people live in extreme poverty while over 10 million people suffer from chronic food insecurity and poor nutrition. In recent years, it is estimated that at any one time about two million people require assistance to access food. During periods of drought, heavy rains and/or floods, the number of people in need could double. Households are also incurring huge food bills due to the high food prices. However, Maina et al; (2011) stated that in developing countries like Kenya, where most of the rural people are involved in agricultural production, adoption of improved agricultural technologies is an important strategy for facilitating households' productive and consumptive capabilities for better livelihoods. Kipkoech (2011),indicated that to boost food security and bridge the gap between vision 2030 blue print target and agricultural projects on the ground, technology has to be applied from the farm through to processing, storage and marketing which also requires the implementation of the right policies, finances, insurances, infrastructures and information.

Mwololo (2013) stated that the uptake of modern farming technologies in Kenya remains low despite the dilemma in cyclical hunger crisis engulfing Kenya and much of East Africa. This can be attributed to lack of sufficient information on modern farming practices, extension services, marketing and post harvest support. He further stated that technological innovation in food production in Kenya is no longer an option but an imperative. This is due to the recent climatic change, regional drought and famine, and chronic food insecurity. That is, rain fed agriculture is unsustainable and must be replaced by alternative mechanisms driven by technology. The study focused on assessment of the influence of technologies on food security among households.

2.7 Farmers Empowerment, Marketing and Food Security

According to oxford dictionary to empower is to make someone stronger and more confident, especially in controlling their life and claiming their rights. Farmers' empowerment entails giving farmers skills, resources, authority, opportunity, motivation, as well as holding them responsible and accountable for outcomes of their actions. These will contribute to their competence and satisfaction. There are different types of empowerment which includes

economic, material, spiritual, social, educational and occupational empowerment. Luttrell and Quiroz (2009) said that empowerment can be broadly defined as 'a progression that helps people gain control over their own lives and increases the capacity of people to act on issues that they themselves define as important'. They further said that a focus on empowerment emphasizes that poverty not only is about low incomes, but also emanates from social exclusion and the lack of access to power, voice and security.

According to World Health Organisation (2013), empowerment refers to the process by which people gain control over the factors and decisions that shape their lives. It is the process by which they increase their assets and attributes and build capacities to gain access, partners, networks and/or a voice, in order to gain control. It assumes that people have their own assets, and the role of the external agent is to catalyze, facilitate or accompany the community in acquiring power. Community empowerment implies community ownership and action that explicitly aims at social and political change. Community empowerment is a process of re-negotiating power in order to gain more control. Community empowerment necessarily addresses the social, cultural, political and economic determinants that underpin health, and seeks to build partnerships with other sectors in finding solutions. However, the Department for International Development (2013), pointed out that, poor people's empowerment and their ability to hold others to account, is strongly influenced by their individual assets (such as land, housing, livestock, savings) and capabilities of all types such as good health and education, social (such as social belonging, a sense of identity, leadership relations) and psychological (self-esteem, self-confidence, the ability to imagine and aspire to a better future). Also important are people's collective assets and capabilities, such as voice, organization, representation and identity.

Broadbent (2010) found that the range of empowerments or interventions are extremely broad, some of these are microfinance, cash transfers, technology and skills development, labour market interventions, land and inheritance rights. These are geared at empowering farmers especially the poor, women and marginalized communities. Arnold, Conway and Greenslade (2011) reported that Cash transfers are thought to promote self-esteem, status and empowerment amongst vulnerable people, enabling them to become active members of their households and communities, rather than perceived as burdens. Cash transfers are also regarded as a particularly effective way of empowering women and girls within the household. By addressing gender imbalances in access to economic resources, and putting cash directly in the hands of women,

cash transfers can increase women's bargaining power within the home and improve intra household allocation of resources. Underutilization, inefficient or non-use of available resources and lack of maximum benefits from the available resources significantly contribute to poor economic conditions in Africa. Smallholder farming based on low-input and traditional farming practices coupled with rapid population growth have negatively impacted on sufficient food production. To empower farmers, agricultural technologies like mushroom production, green house horticultural production, Jatropha production and organic farming and were introduced in Nakuru District.

According to Inter American Development Bank (IDB,2013), to maintain or increase agricultural growth and to face the challenges of feeding an increasing population and adapting to the impacts of climate change, there is a need to help farmers increase their productivity with greater access to markets, better agricultural services and increased investments. Researchers have further reported that substantial gains in agricultural productivity can be realized through investment, innovation, policy and other improvements. To realize these gains, collaboration among stakeholders in the agricultural value chain, including governments, companies, multilateral and civil-society organizations, farmers, consumers and entrepreneurs is required. Markets are important in promoting productivity and food security.

2.8 What may hinder adoption of Agricultural Technologies

According to Roger (2003) the innovation decision process involve different stages namely knowledge, persuasion, decision making, implementation, confirmation and adoption. At the decision Stage, a person makes the choice to reject or adopt the technology. This personal process involves the weighing of advantages, disadvantages, costs, benefits, and trade-offs.

The process of adoption over time is typically illustrated as a classical normal distribution or bell curve. The model indicates that the first group of people to use a new product is innovators, followed by early adopters, then early and late majority, and finally laggards. The graph below shows technology adoption lifecycle model (Figure 1).

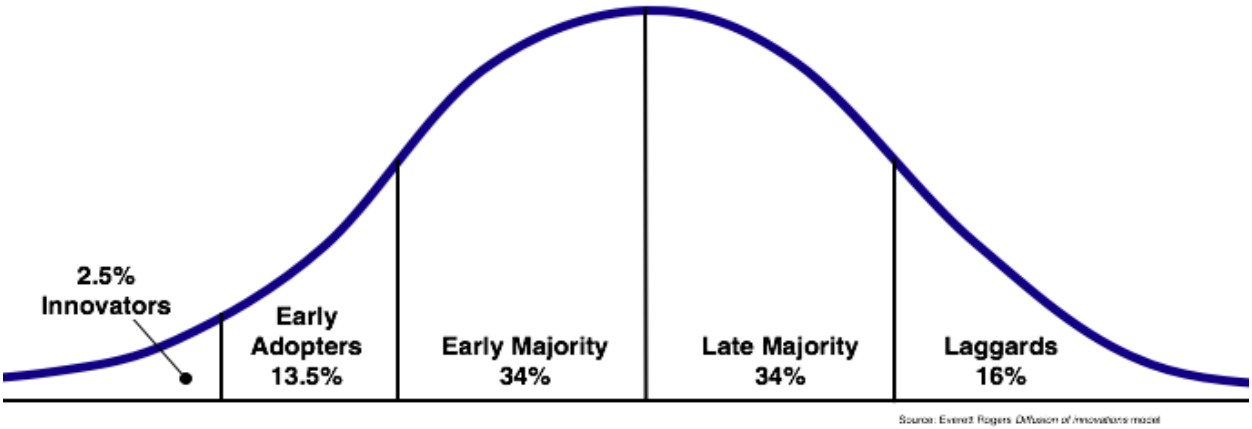

Figure 1 A graph of Everett Rogers Technology Adoption Lifecycle model

According to Hans (1989), agricultural researches have been ineffective because in most cases researchers fail to build on the practice and experience of the people and the farmers whose problems they were to address. Thus not fully incorporating the enormous amount of human capital embedded in traditional farming skills. These make research recommendations that were inconsistent with traditional farming practices to be rejected by traditional farmers who had knowledge and experience of the region and the crops. Another challenge facing implementation of recent technologies is that researchers have not been sufficiently motivated and therefore national agricultural research systems have experienced a massive migration to abroad, universities and the private sector in search for greener pastures and for fulfillment in the circumstances of poor remuneration and inadequate equipment and materials for research at home. Appropriate and affordable technologies have therefore not been adopted. Hans (1989) further pointed out that there is hardly any country that is self sufficient in food without a history of substantial subsidies on agriculture. African countries must therefore devise carefully packaged subsidy programmes that are consistent with the carrying capacity of their resources, non inflationary growth and fiscal balance. Subsidies are effective in relieving the farmers and consumers and must not fall into the hands of intermediaries between farmers and consumers.

According to Beye (2002), national agricultural research systems sometimes have defective institutional structures which have discouraged active integration of research training and extension service, the poor funding and staffing of research institutes and the failure to effectively disseminate even the limited research results that are available. The limited research results have not been able to reach farmers because of inaccessibility, while price incentives have

not reached the farmers because of numerous market intermediaries. Further, Poor deficient rural road networks also affect harvesting and transportation of agricultural products to the market. Heidhues etal (2004) said that many African governments have not shown adequate political will and commitment to successfully push through programmes of self reliance and food security. Even where these objectives had been nominally declared, they have not been translated into programmes and budgetary priorities. Policies have been inconsistent, unharmonized and discontinuous. Zhou (2008) reported that a major role of agricultural extension in developing countries has been to disseminate technologies generated by public sector research organizations through appropriate dissemination strategies such as demonstrations, field visits, farmers' meetings and use of media. The extension service is one of the critical change agents required in transforming subsistence farming to a modern and commercial agriculture to promote household food security, improve income and reduce poverty. However, extension staffs are sometimes inadequate and therefore there is a need to recruit more extension staff and the involvement of NGO's to increase access of extension services to farmers.

Nzioki (2009) indicated that Women play a significant role in African agriculture. About 70% of the agricultural workers, 80% of food producers, and they also undertake 60 to 90% of the rural marketing, thus making up more than two-third of the workforce in agricultural production. However the contribution of women in Kenyan agriculture has not received adequate policy recognition and therefore women face constraints while accessing farm credit, land and other production inputs. The introduction of new agricultural technologies has not always been gender neutral as some new innovations have unwittingly imposed economic losses on women in agriculture. United Nations Conference on Trade and Development (2010) pointed out that a balanced technology acquisition approach must balance the contrasting challenges of technology selection, adaptation and diffusion. It is not enough for a technique to be technically sound, it must also be adapted to suit the specific conditions found on the ground, and be made affordable and attractive enough to smallholder farmers to achieve wide diffusion. Models of public-private partnership that make not only public institutes but also for-profit enterprises into stakeholders for the diffusion model can be valuable in building a self-sustaining momentum behind dissemination efforts. Such a model stands the best chance of being demand driven succeeding because farmers demand its continuation, rather than due to a top down bureaucratic decision.

Food and Agriculture Organisation (2011) indicated that small scale farmer plays a central role in the agricultural production process. Some government policies, especially at the level of

implementation, have discriminated against the small scale farmer. Yet over 80per cent of marketed surpluses and supplies come from small scale farmers. That is, policies and researches fail to recognize the large stock of scientific knowledge, which the small-scale farmer has acquired through the process of inter generational transfer of farming skills, based on trial and error methods. Agricultural technologies must therefore focus not only on intercropping and the smallness of scale but more generally incorporate a complete understanding of why farmers do what they do and how they can do them better, cheaper or even with reduced effort. Jack (2011) further stated that many technologies might enjoy higher adoption rates if credit markets offered low interest loans or if property rights were secure.

International Fund Agricultural Development (2012) indicated that there has been neglect of irrigated agriculture, especially of the small and medium scale type, through which Africa's dependence on rain fed agriculture could be reduced, thereby promoting increased African food production in the process. Lack of institutionalized farm credit for the small scale farmer has adversely affected the adoption of innovations and the expansion of the scale of farming operations. Population Reference Bureau (2013) pointed out that human population is growing faster than its food production. While food production increases annually by 2%, the annual population growth rate is 3.2%. African leaders are therefore required to sensitise on population control.

2.9 Theoretical Framework

This study is based on diffusion of innovation' model or theory suggested by Rogers (1962). Diffusion is the process by which an innovation is communicated through certain channels over a period of time among the members of a social system. An innovation is an idea, practice, or object that is perceived to be new by an individual or other unit of adoption while communication is a process in which participants create and share information with one another to reach a mutual understanding. (Rogers, 1995).

Zhou (2012) indicated that this model help agricultural workers to communicate new technologies to farmers. This help in the promotion of agricultural messages designed and developed by research scientists with limited input from the technology users (farmers). It is now widely recognized that innovation comes from multiple sources, including farmers and how the agendas of different stakeholders are represented affects the 'appropriateness' of new technology developed (Suleiman et al, 2006). In order to advance agricultural innovation it calls for building

of institutionally sustainable innovation systems, which can be gauged by growing interrelations between the participants in the innovation system, an intensive communication between all stakeholders such as public sector, the private non-profit sector and the private for profit sector. If an innovation or agricultural technology is adopted by farmers, farm productions are improved and hence food security status improved. The study looked into how implemented agricultural technologies influence food security among households.

2.10 Conceptual Framework

The conceptual framework of the study given in Figure.1 shows the interaction of various factors that influence food security in the study area. The theoretical basis for developing the conceptual framework is diffusion and adoption postulated by Rongers in 1962 that an innovation (new technology) after being communicated to farmers is adopted and hence farm productions improved and hence food security status improved. Various agricultural technologies (mushroom production, organic farming and green house horticultural farming) all geared at empowering farmers contribute positively or negatively to food security. The study has independent variables which include agricultural technologies namely Mushroom farming, organic farming, green house horticultural production, farmers' empowerment, marketing of farm produce and challenges of implementing agricultural technologies.

The study has food security among household as dependent variable (Figure 2). A household of six persons is food secure if it has six (6) bags of maize (Ksh.2500 per bag) and two bags of beans (Ksh.4000 per bag). So besides Mushroom and horticultural produce being used as food, they generate income which can be used to purchase staple food. The moderating and intervening variables also influence food security directly or indirectly. That is indirectly by affecting the implementation of agricultural technologies and consequently contributing positively or negative food security or directly affecting food security.

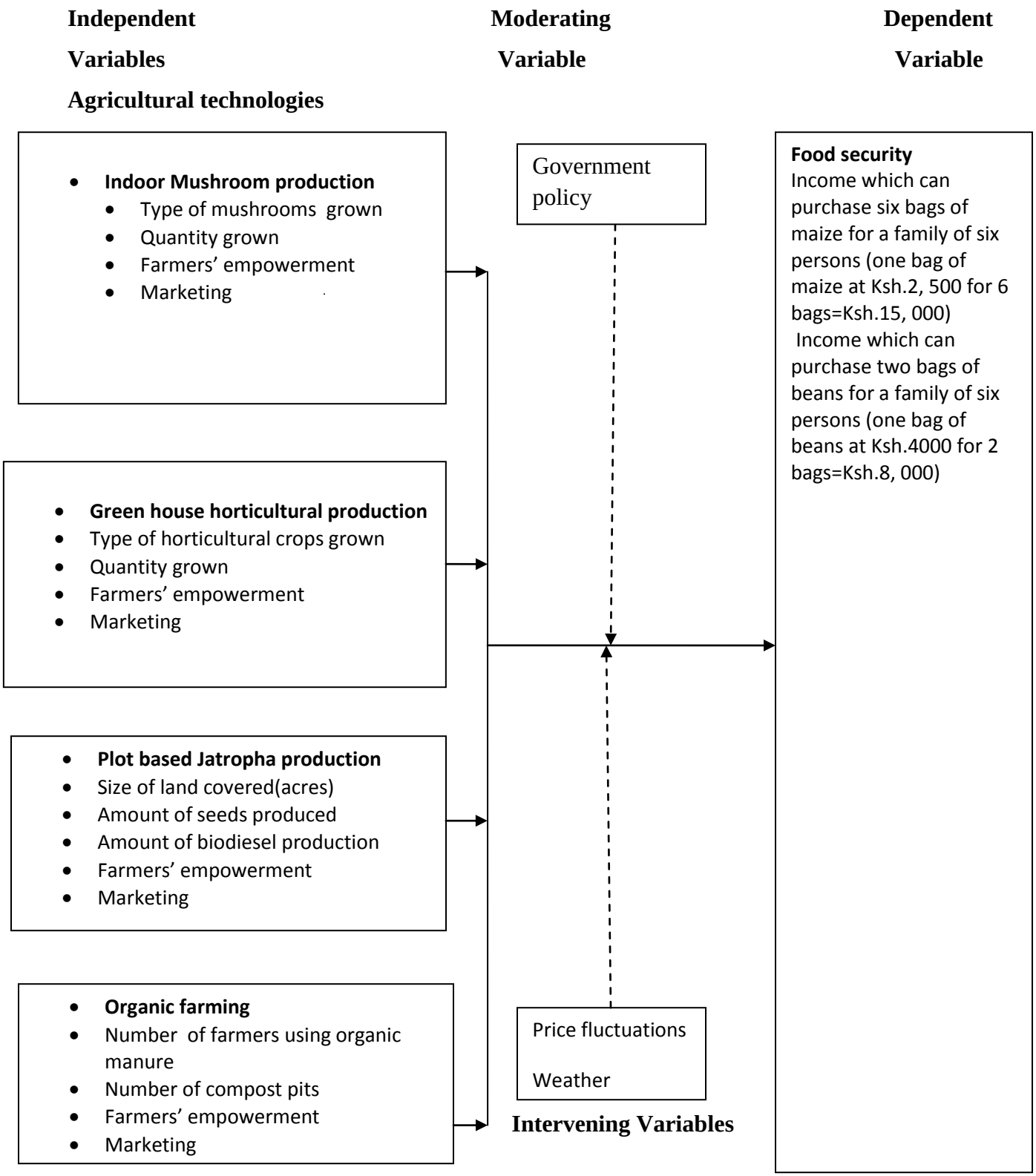

Figure 2. Conceptual Framework of the Study

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research methodology which was used in the Study, the target population, Sampling procedures, the sample size and the sampling frame, data collection methods, data collection instruments and data analytical procedures employed in the study.

3.2 Research Design

Data was collected using a descriptive survey design. The design was used because it looks at the phenomena, events and issues the way they are (Mugenda and Mugenda, 2003).The design was able to identify factors which affect recent agricultural technologies in Lanet and Barut Divisions. The design was used because it examined and looked at the problem at hand thoroughly to define it, clarify it and obtain pertinent information that can be of use to stakeholders in agriculture. The design also accommodated large sample sizes and it is good in generalization of the results. It is also easy to administer and record answers in this design.

3.3 Target Population of the Study

The study focused on Lanet and Barut Divisions of Nakuru District .The Population under the study comprised of 10,423 households with 7566 households from Lanet Division and 2857 households from Barut Division, which are undertaking farming activities. The sample on which the study will be carried out will be randomly drawn from the 10,423 households.

3.4 Sample Size and Sampling Procedures

This study considered a sample of 212 respondents. According to Yamene (1967), a total of 10,423 households required a sample of 200 households. Stratified random sampling combined with proportionate sampling was used in this study resulting to 200 households. This is 145 households from Lanet Division (109 households from Free Area Location and 36 households from Lanet Location) and 55 from Barut Division (31 households from Kapkuress Location and 24 households from Barut Location). In addition, 6 group leaders and 6 extension staffs filled questionnaires. In total, 212 respondents filled questionnaires as shown in Table 3.1. This Study used stratified sampling since two Divisions were covered. Proportionate sampling was used because each Division was allocated a sample of households depending on its proportion to the

total number of households. Proportionate sampling enabled the researcher to achieve greater representativeness in the sample of the population. This was accomplished by selecting individuals at random from subgroups (stratified random sampling) in proportion to the actual size of the group in the total population (Van Dalen, 1979).

Table 3.1 Sampled households from Lanet and Barut Divisions

Division	Location	Number of households practising farming	Sample size
Lanet	Free area	5,675	109
Lanet	Lanet	1891	36
Barut	Kapkuress	1625	31
Barut	Barut	1232	24
Extension staff			6
Group leaders			6
Total			212

3.5 Data Collection Procedures

The researcher started by acquiring authority to conduct Research from the District Commissioner and from ministry of higher education before commencing the study. This was followed by visiting of the study area to meet provincial administration, local leaders, opinion leaders and group leaders. Agricultural officers working in the Division and Locations in the study area were briefed of the intended research. During this period, questionnaires were pretested and ambiguous questions clarified. Any omissions made were inserted and irrelevant questions omitted. Then actual field work was carried out which entailed collecting primary data from the respondents using drop and pick method. Some questionnaires were filled and collected while others were collected after two days. Responses to questionnaires were recorded objectively and accurately.

3.6 Data Collection Instruments

The study used questionnaires to collect data. The questionnaires obtained data from 212 respondents (200 households, 6 extension staff and 6 group leaders). Questionnaire was chosen because a large population was considered and too, its simplicity of administration on a large population sample (Babbie, 2001).

3.7 Validity of Instruments

Validity is the accuracy, soundness or effectiveness with which an instrument measures what it is intended to measure. In this study, the instruments were first discussed between the researcher and the supervisor who provided his expertise and ensured that the instruments measured what they intended to measure as recommended by Kumar (2005).This was further ascertained by a panel of extension experts or scientists drawn from ministry of Agriculture and private sector. The panel ensured that the items adequately represented concepts that cover all relevant issues under investigation, which complied with recommendations of Mugenda and Mugenda (2008).

Also pilot testing was done on 10 respondents. The respondents were encouraged to make comments and suggestions concerning the instructions, clarity of questions asked and their relevance. From the analysis of the data collected during pilot testing using statistical package for social scientists, the instruments were found to be reliable and hence used in the main research study.

3.8 Reliability of Instrument

Reliability refers to the aspect of stability or repeatability. It concerns if the measurement can give consistent results over time. The researcher used the parallel forms or equivalent forms method. The two instruments were designed as equivalent to each other as possible. Responses from the instruments administered to the same group and during the same period when compared yielded the same results consistently.

3.9 Data Analysis Techniques

The questionnaires will be edited for the purpose of checking on completeness, clarity and consistency in answering research questions. Then the data was coded, tabulated and analysed using Statistical Package for Social Sciences and Ms Excel based on the study objectives. Descriptive statistics using measures of central tendency (mean, mode and median) was computed. The study findings were presented using percentages and tables in making interpretations.

3.10 Ethical Considerations

The researcher received informed consent from respondents to be involved in the study. The researcher was honest with respondents and other participants throughout the study. He remained impartial and kept respondents and their responses confidential.

3.11 Operational Definition of Variables of the Study

The operational definition of variables of the study is given in Table3.3.The study has food security among households as dependent variable. Food security is the ability to have sufficient food throughout the year. This also refers to having an income which can purchase the required food stuffs. In Lanet and Barut Divisions, a household of six persons required six bags of maize (Ksh.2500 per bag) and two bags (Ksh.4000 per bag).So besides Mushroom and horticultural produce being used as food, they generate income which is used to purchase staple food. The independent variable is recent agricultural technologies. Mushroom farming starts with house building, purchase of planting materials, management, processing, packaging and marketing. Besides eating mushroom at household level, the money got from sales can be used to purchase cereals like maize and pulses like beans. Green house horticultural farming starts with green house construction, purchase of planting materials, planting, management, harvesting, and marketing. Besides eating horticultural products at household level, the money got from their sales can be used to purchase cereals like maize and pulses like beans. Jatropha farming starts with land preparation, purchase and planting of seeds, management, harvesting and processing of seeds. Jatropha seeds when sold generate income. When Jatropha seeds are processed, they produce biodiesel which can generate more income than seeds. The money obtained from sale of seeds and biodiesel can be used to purchase cereals like maize and pulses like beans Organic farming improves productivity of farm produce with little or no investment in inorganic fertilizers. Organic manure when sold generates income which can be used to purchase food stuffs.

Table 3. 3 Operational Definition of Variables of the Study

Objectives	Variables	Indicators	Measure(s)	Measurement scale	Type of analysis
To assess how indoor mushroom production influence food security among households	Mushroom production	Mushroom farmers Mushroom types Produced mushroom Mushroom marketing Mushroom products Mushroom sales Farm inputs support	No. of mushroom farmers Types of mushroom grown Quantity produced Types of markets Quantity sold Amount of income obtained Value of farm inputs support	Ratio	Descriptive
To determine how green house horticultural production influence food security among households	Green house horticultural production	Green houses Horticultural production Markets available Horticultural products	No. of horticultural green houses Quantity produced Types of markets Quantity sold Amount of Income obtained Value of farm inputs support	Ratio	Descriptive

To assess how Plot based Jatropha production influence food security among households	Jatropha production	Jatropha seeds produced Amount of biodiesel extracted	Amount of biodiesel produced in litres Quantity sold Amount of income obtained Types of markets Value of farm inputs support	Ratio	Descriptive
To assess how Organic Farming influence food security among households	Organic farming	Organic manure produced	No. of farmers using organic manure Number of compost sites Amount of manure in Kgs produced	Ratio	Descriptive

	Dependent Household food security	Improved food production	Types of food stuff in store No. of households with food stuff harvested Amount of farm produce harvested(in Kg) No. of households with stored food Amount of food stuffs in store Amount of income generated(in Ksh)	Ratio	Descriptive

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter contains data analysis, presentation and interpretation of findings. The study intended to assess agricultural technologies influencing food security among households in Lanet and Barut Divisions of Nakuru District. The chapter discusses results of the study under the following headings: questionnaire return rate, description of the study subjects, contribution of agricultural technologies on food security among households, mushroom production among households, green house horticultural production among households, Jatropha production among households and organic farming among households.

4.2 Questionnaire Return Rate

The questionnaire return rate was 100%, as 212 questionnaires were used. This was possible since the questionnaires were administered by trained research assistants who administered questionnaires, waited for the respondent to complete and collect immediately. In cases where the questionnaires were left behind, they were collected the following date. This ensured that the sample size remained as designed thus ensuring representativeness of the target population.

4.3 Demographic Characteristics of the respondents

This section discusses the respondent's gender, age, level of education, marital status, family size and land size. These attributes were relevant to the study since they have a bearing on the respondent to provide information that is valid, reliable and relevant to the study.

4.3.1 Distribution of the respondents by gender

The respondents from Barut and Lanet Divisions who actively engage in agricultural production were asked to state their gender. The responses are shown in Table 4.1

Table 4.1 Gender of the respondents

Gender of respondent	Frequency	Percentage
Male	82	38.7
Female	130	61.3
Total	212	100.0

The findings show that majority of the respondents interviewed were female 130(61.3%) while male were 82(38.7%).The study shows that majority of the respondents were female.

4.3.2 Distribution of the respondents by age

The respondents were asked to indicate their ages from among choices of age classes given. The use of these classes minimized the number of individual responses and allowed easy classification and analysis of the information. The age of the respondent has an influence on the ability to engage in food production activities. The respondents responses are shown in Table 4.2

Table 4.2 Age of respondents

Age of respondent in years	Frequency	Percentage
16-25	6	2.8
26-35	34	16.0
36-45	78	36.8
46- 55	87	41.0
Over 55	7	3.4
Total	212	100.0

The findings show that 87 respondents (41%) are in age bracket of 46-55 years and 78 respondents in 36-45 years. Therefore, the research findings show that 165 respondents (77.8%) are in age bracket of 36-55 years. This indicates that majority of the respondents are in their middle age and therefore suitable in undertaking agricultural technologies which require effective decision making. Age influences farm level decisions that underlie empowerment such as membership to farmer groups, leadership roles and participation in social networks.

4.3.3 Distribution of the respondents by their level of education

Education level of the respondent represented the level of formal schooling completed by the respondent at the time of the study. The respondents were asked to indicate their highest level of education and Table 4.3 shows the results.

Table 4.3 Respondent level of education

Level of education	Frequency	Percentage
Never went to School	9	4.2
Primary level	58	27.4
Ordinary level	95	44.8
Advanced level	38	17.9
Degree level	11	5.2
Masters level	1	0.5
Total	212	100.0

The findings show that 9 respondents (4.2 %) never went to school, 58 respondents (27.4%) had primary education, 95 respondents (44.8%) had secondary education, 38 respondents (17.9%) had advanced education, 11 respondents (5.2%) attained degree education, 1 respondent (0.5%)with masters and only. Majority of the respondents 58(27.4%) had attained ordinary level of education and thus the literacy level in the study area was high. This indicates that majority of the respondents are literate and therefore suitable in undertaking agricultural technologies which require high technical knowhow.

4.3.4 Marital status of the respondents.

The respondents were asked to indicate their marital status. Table 4.4 shows the distribution of the respondents by marital status.

Table 4.4 Marital status of the respondents

Marital status	Frequency	Percentage
single	23	10.8
married	177	83.5
Widow	10	4.7
Widower	2	0.9
Total	212	100.0

The findings indicate that 23 respondents (10.8%) were singles, 177 respondents (83.5%) of were married, 10 respondents (4.7%) were widows and 2 respondents (0.9%) were widowers. The findings show that majority of the respondents were married. Marriage ascribes familial responsibilities to farmers and therefore farmers become more serious in terms of their participation in agricultural technologies that would give them access to more food and income to meet their responsibilities.

4.3.5 Household size of respondent

The respondents were asked to indicate their household size. Table 4.5 shows the distribution of the respondents by household size.

Table 4.5 Household size of the respondent

Households size (persons)	Frequency	Percentage
1	2	0.9
2	5	2.4
3-5	130	61.3
6-8	65	30.7
9-11	6	2.8
over 11	4	1.9
Total	212	100.0

The results indicate that 130 households (61.3%) had 3-5 persons while 65 households (30.7%) had 6-8 persons. Therefore, 195 households (92%) had 3-8 persons. According to the study, a

household of 6 persons is considered food secure if it has six bags of maize and two bags of beans or an income which can purchase six bags of maize (one bag of maize at Ksh.2, 500 for 6 bags=Ksh.15, 000) and two bags of beans (one bag of beans at Ksh.4000 for 2 bags=Ksh.8, 000). This implies that on average each household has six persons and thus require six bags of maize and two bags of beans or income of 23,000 Kenya shillings.

4.3.6 Land size of respondent

The respondents were asked to indicate their land size. Table 4.6 shows the distribution of the respondents by land size.

Table 4.6 Land size of the respondent

Land size in Acres	Frequency	Percentage
0.125-0.25	11	5.2
0.26-0.5	30	14.2
0.6-1	75	35.4
1.1-2	64	30.2
2.1-3	13	6.1
3.1 and over	19	9.0
Total	212	100.0

The results indicate that 11 respondents (5.2%) had 0.125-0.25 acres, 30 respondents (14.2%) had 0.26-0.5 acres, 75 respondents (35.4%) had 0.6-1 acres, 64 respondents (30.2%) had 1.1-2 acres, 13 respondents (6.1%) had 2.1-3 acres and 19 respondents (9.0%) had over 3.1 acres. Majority of the respondents (35.4%) had 0.6-1 acres of land. The average land size per household within the study area has been declining over the years and hence the need for adoption of agricultural technologies which require small pieces of land for optimal production.

4.4. Mushroom production on food security among households

Mushroom production is a recent introduction in Kenya (1970) but the production is picking up. The bulk of Mushroom production comes from large scale farms but small scale farmers are adopting it.

4.4.1 Households growing mushroom

According to the Ministry of Agriculture, Kenya produces 500 tonnes per annum (of which 476 tons being button) against an annual demand of 1200 tons both in hotels and home consumption. The respondents were requested to indicate whether they have been practicing mushroom farming. Table 4.7 shows the households growing mushrooms.

Table 4.7 Households growing Mushroom

Mushroom farming	Frequency	Percentage
Yes	12	5.7
No	200	94.3
Total	212	100.0

The findings show that only 12 respondents (5.7%) are practising mushroom farming while 200 respondents (94.3%) households are not practising mushroom farming. This shows that mushroom farming is low among the respondents.

4.4.2 Mushroom production among households

The respondents were asked to indicate the production of mushroom in 2010, 2011 and 2012.Table 4.8 shows the findings.

Table 4.8 Quantities of mushroom produced

Year	Quantities produced (Kg)	Mean production (Kg)	Frequency of respondents	Total production	Percentage of respondents
2010	1-200	100.5	8	804	3.8
2011	1-200	100.5	4	402	1.9
2012	1-200	100.5	7	703.5	3.3
Total				1909.5	

The findings indicate that in 2010, 8 respondents (3.8%) produced 1-200kgs of mushroom; in 2011, 4 respondents (4%) produced 1-200kgs and in 2012, 7 respondents (3.3%) produced 1-200kgs.The findings indicated that the production of mushroom over the three years is 1909.5 Kilogrammes. The production is low despite the great demand both locally and internationally. Table 4.9 shows the reasons of not practicing mushroom farming.

Table 4.9 Reasons of not practicing mushroom farming

Reasons of not practising Mushroom farming	Frequency	Percentage
Do not know about it	84	39.6
Lack of technical knowhow	38	17.9
Lack of capital	56	26.4
Limited land	14	6.6
Lack of market	8	3.8
Not applicable	12	5.7
Total	212	100.0

The research findings indicate that respondents do not practice mushroom farming because 84 respondents (39.6%) do not know it,38 respondents (17.6%) lack technical knowhow, 56 respondents (26.4%) lack of capital, 14 respondents (6.6%) have small land sizes and 8 respondents (3.8%) lack markets for mushrooms. The study therefore shows that majority of respondents do not practice mushroom due to lack of capital.

4.4.3 Mushroom consumption and food security

Globalization is affecting food production and consumption chains worldwide. Mushroom consumption has been increasing over the years though slowly. There is a need to promote mushroom production and consumption since the research have shown that many farmers (39.6%) refer to Table 4.9,do not practise mushroom farming because they do not know mushroom and how it is grown. Table 4.10 shows the consumption of mushroom among the respondents.

Table 4.10 Mushroom consumption

Consumption (Kg)	Frequency	Percentage
none	200	94.3
1-200	12	5.7
Total	212	100.0

The findings indicate that 12 respondents (5.7 %) consume mushroom in the range of 1-200kgs per year. Mushrooms are important commodity in Barut and Lanet Divisions, whose production has been increasing. However, consumption levels are low at the local household's level since farmers have not understood the importance of mushroom as far as nutrition is concerned. There is a need to promote mushroom production and consumption especially in the rural areas where food insecurity is prevalent.

4.4.4 Mushroom marketing and food security

Marketing of mushroom products by households help farmers in getting income which can be used in purchasing of other food stuffs. In this study, respondents were asked to indicate where they sell their mushroom products. Table 4.11 shows mushroom markets

Table 4.11 Mushroom markets

Mushroom market	Frequency	Percentage
Not applicable	200	94.3
Farm gate	1	0.5
Supermarkets	2	0.9
Balm of Hope	9	4.2
Total	212	100.0

The findings show that 1 respondent (0.5%) sell his/her mushroom at farm gate, 2 respondents (0.9%) of respondents sell to supermarkets and 9 respondents (4.2%) sell to Balm of Hope**.** The study shows that majority of those who grow mushroom sell it to Balm of Hope. Balm of hope is a self help group who grows their own mushroom, buy from other farmers, process and sells products to supermarkets. Balm of Hope Self Help group is registered with Kenya Bureau of standards (KEBS). Markets are important channels of promoting productivity and food security. Table 4.12 shows the quantities of mushroom sold.

Table 4.12 Quantities of Mushroom sold

Mushroom (Kgs)	Frequency	Percentage
None	200	94.3
1-200	11	5.2
601-800	1	0.5
Total	212	100.0

The findings show that majority of respondents 11 (5.2%) sell 1-200kgs and 1 respondent (0.5%) sell 601-800kgs of mushroom products. The income obtained from mushroom sales is shown in Table 4.13.

Table 4.13 Income from mushroom sales

Amount (KShs)	Median	Frequency	Total income (KShs)	Percentage
None	0	200	0	94.3
1-5000	2,500.5	4	10,002	1.9
10001-20000	25,000.5	6	150,003	2.8
30001-40,000	35,000.5	1	35,000.5	0.5
over 40,000	40,000	1	40,000	0.5
Total		212	235,006	100.0

The study show that 4 respondents(1.9%) respondents got 1-5,000 Kenyan shillings from mushroom sales,6 respondents(2.8%) got 10,001-20,000 Kenyan shillings,1 respondent(0.5%) got 30,001-40,000 Kenyan shillings and 1 respondent(0.5%) got over 40,000 Kenyan shillings from mushroom sales. According to the findings, mushroom production provides food at the household level besides generating income which can be used in purchasing food stuffs. Therefore, Mushrooms play an important role in offering employment to a big portion of population, generating income and providing food.

4.4.5 Farmers empowerment through farm inputs

Respondents were asked to indicate the amount of support they have received from various service providers and the findings are shown in Table 4.14.

Table 4.14 Service providers

Farmers support (Ksh.)	Frequency	Percentage
None	211	99.5
100001-150,000	1	0.5
Total	212	100.0

The research shows that only 1 respondent (0.5%) got financial support in form of finances of 100001-150,000 shillings. It is therefore important that service providers support small scale farmers with farm inputs. This will enable vulnerable small scale farmers to produce mushroom products. There is also a need to determine methods of identifying cost-effective ways to improve access to inputs, improving delivery and assisting farmers to earn cash to purchase inputs thereby improving food security.

4.5 Green house horticultural production, marketing, income generation and food security

Green houses enable farmers to control the climate of their crops, preventing the damaging effects of drought, flood, and other extreme weather conditions. This has made farmers to undertake Greenhouse framing which is a new and exciting technology in Kenya. The study looked at the number of respondents carrying out greenhouse farming, Reasons of not practising green house farming, types of green house horticultural crops grown, quantities of mushroom grown, quantities consumed, quantities sold and income generated for sales. Findings are shown in form of tables.

4.5.1 Green house crop production among households

Faced with reduced acreage for farming due to population growth and unpredictable weather conditions, farmers in the study area are turning to greenhouse farming technology as a way to increase food production and supplement their income. Table 4.15 shows the number and percentage of respondents practicing green house horticultural production.

Table 4.15 Households practising green house horticultural farming

Practising green house horticultural farming	Frequency	Percentage
Yes	21	9.9
No	191	90.1
Total	212	100.0

The study shows that 21 respondents (9.9%) are practising green house horticultural farming in the study area. The low adoption of this technology is due to various challenges faced by horticultural farmers. These include misallocation and under investment in agriculture, disengagement of government support to agriculture, poor infrastructure, high cost of inputs, limited access to extension services, unreliable weather, and low produces Prices. Farmers in Lanet and Barut Divisions who are small scale farmers with majority having 0.6-1 acre of land as shown in Table 4.6, undertake green house horticultural crops production for household consumption and for income generation. Table 4.16 shows the reasons why some Barut and Lanet farmers have not undertaken green house horticultural production.

Table 4.16 Reasons of not practising green house horticultural production

Reasons of not undertaking green house horticultural production	Frequency	Percentage
Limited land	32	15.1
no technical know how	46	21.7
lack of capital	82	38.7
water shortage	27	12.7
lack of market	4	1.9
not applicable	21	9.9
Total	212	100.0

The findings show that 32 respondents(15.1%) had limited land,46 respondents (21.7%) respondents had no technical know how,82 respondents (38.7%) respondents lacked capital,27 respondents (12.7%) had water shortage and 4 respondents (1.9%) were not sure of getting green house horticultural products market. Lack of capital was the worst challenge faced in green

house horticultural production. The increasing population in Lanet and Barut Divisions poses a great challenge to production of adequate food and materials with available land and other natural resources. The situation is exacerbated by occasional adverse weather phenomena such as drought and extreme conditions which damage crops, resulting in low agricultural yields and produce quality. In such a situation, protected production within greenhouses has offered a means of increasing productivity by addressing these challenges. Production in green houses has lead to improve water use efficiency, reduced incidence of pests and enhance production of a range of horticultural crops. Table 4.17 shows the types of horticultural crops grown in the study area.

Table 4.17 Types of horticultural crops grown in the study area

Types of horticultural crops grown	Frequency	Percentage
not applicable	191	90.1
Tomato	11	5.2
Tomato/Capsicum	3	1.4
Tomato/capsicum/ cucumber	2	0.9
Tomato/Capsicum/Spinach	1	0.5
Tomato/Capsicum/onions	2	0.9
Tomato/spinach	1	0.5
Tomato/vegetables/onions	1	0.5
Total	212	100.0

The findings indicate that 21 respondents (9.9%) are practising green house horticultural production with 11 respondents (5.2%) growing only tomatoes in their green houses. The remaining households grow tomatoes combined with other crops like capsicum, cucumber, spinach, onions and vegetables. Table 4.18 shows the quantities of green house horticultural crops produced.

Table 4.18 Quantities of green house horticultural crops produced

Quantities of crops produced (Kgs)	Median	Frequency	Total Production (Kgs)	Percentage
none	0	191	0	90.1
1-1000 kgs	500.5	6	3003	2.8
1001-4000kgs	2500.5	9	22,504.5	4.2
4001-8000 kgs	6000.5	2	12,001	0.9
8001-10000kgs	9000.5	1	9000.5	0.5
over 10,000 kgs	10,000	3	30,000	1.4
Total		212	76,509	100.0

The study shows that 9 out of 21 households (4.2%) produced 1001-4000kgs of horticultural products .Only one household produced 8001-10,000kgs which was recorded as the highest. The study also shows that all the 21 respondents produced 76,509 kilogrammes.

4.5.2 Green house horticultural crops marketing

The growth in greenhouse horticultural production in the study is driven by farmers demand for food, employment and income generation. Greenhouse farmers use several channels to market their produce. Table 4.19 shows the markets where respondents sold their green house horticultural products.

Table 4.19 Markets where respondent sell their horticultural products

Markets	Frequency	Percentage
not applicable	191	90.1
Farm gate	5	2.4
Supermarkets	12	5.7
Hotels	2	0.9
Open air market	2	0.9
Total	212	100.0

The study shows that 5 respondents (2.4%) sold their green house products at farm gate, 12 respondents (5.7%) to supermarkets, 2 respondents (0.9%) to hotels and 2 respondents (0.9%) to open air markets. This shows that the respondents sell their green house products locally and it is therefore important that farmers in the study should penetrate the export market for more incomes. Table 4.20 shows the income obtained from green house horticultural crops sales.

Table 4.20 Amount of income obtained from green house horticultural crops

Amount of income (KShs)	Frequency	Median (income)	Total income (KShs)	Percentage
None	191	0	0	90.1
1-10000	5	5000.5	25002.5	2.4
50001-100,000	3	75,000.5	225001.5	1.4
100001-200000	2	150,000.5	300,001	0.9
200001-300000	4	250,000.5	1000002	1.9
over 300,000	7	300,000	2,100,000	3.3
Total	212		3,650,007	

The research findings show that 5 respondents (2.4%) obtained income of 1-10,000shillings, 3 respondents (1.4%) obtained income of 5,001-100,000shillings, 2 respondents (0.9%) obtained income of 100,001-200,000shillings, 4 respondents (0.9%) obtained income of 200,001-300,000shillings but majority of the respondents 7 (3.3%) obtained an income of over 300,000 Kenya shillings. The findings further indicate that a total of 3,650,007 Kenya shillings were obtained from total sales of green house products from the study area.

4.5.3 Green house farmers empowerment (farm inputs)

Small scale farmers' especially vulnerable groups, such as the very poor, women and marginalised communities often lack the skills, resources and confidence to engage in community decision-making. It may therefore be important to support mechanisms designed to specifically target marginalised groups in order to ensure that they can participate in food production for food security. Table 4.21 shows the green house farm input providers.

Table 4.21 Green house farm input providers

Input provider	Value of farm input (KShs)	Frequency	Percentage
None	none	208	98.1
Ministry of Agriculture	100,001-200,000	1	0.5
Constituency Development Fund	200,001-300,00	2	0.9
Child Mother Fund	50,001-10,000	1	0.5
Total		212	100.0

The findings show that 1 respondent (0.5%) was supported by Ministry of Agriculture with farm inputs worth 100,001-200,000 shillings, 2 respondents (0.9%) by Constituency Development Fund with farm inputs worth 200,001-300,000 shillings and 1 respondent (0.5%) by child mother fund with farm inputs worth 50,001-100,000 shillings. The supported households acted as demonstration sites where other respondents have been trained. Lack of support to vulnerable farmers would increase food insecurity.

4.6 Jatropha production and food security among households

Jatropha plant is viewed as a potential biodiesel feedstock that is capable of growing in marginal areas where other crops cannot yield satisfactorily. The most common uses of Jatropha include fencing, cow's shelter, income generation and soil conservation. When planted as a cow shelter, the plant does not require application of fertilizer or manure.

4.6.1 Jatropha Production

Jatropha curcas has been widely promoted by Panda pata nongovernmental organization and other development agencies in the study area as viable for biodiesel feedstock in Kenya. Table 4.22 shows number of respondents growing Jatropha in the study area.

Table 4.22 Number of respondents growing Jatropha

Practising Jatropha production	Frequency	Percentage
Yes	10	4.7
No	202	95.3
Total	212	100.0

The findings show that 10 respondents (4.7%) are growing Jatropha in the study area. Most of the planted crop is in flowering stage and therefore full production is yet to be achieved. Table 4.23 shows reasons why most farmers have not adopted this technology.

Table 4.23 Reasons of growing Jatropha

Reason of not growing Jatropha	Frequency	Percentage
No technical know how	131	61.8
Limited land	25	11.8
No capital	27	12.7
Lack of planting material	14	6.6
Not known the market or lack of market for Produce	5	2.4
Not applicable	10	4.7
Total	212	100.0

The findings show that 131 respondents (61.8%) do not know how to grow the crop, 25 respondents (11.8%) lack adequate land, 27 respondents (12.7%) have no capital, 14 respondents (6.6%) lack planting material while 5 respondents (2.4%) do not know where to market Jatropha. Unlike Mushroom and green house horticultural technologies which are not land intensive, Jatropha production require availability of land. Table 4.24 shows the number of Jatropha trees grown in the study area.

Table 4.24 Number of Jatropha trees grown

Number of Jatropha trees	Frequency	Percentage	Median	Number of trees
none	202	95.3	0	0
1-100	4	1.9	50.5	202
101-300	4	1.9	200.5	802
301-500	2	0.9	400.5	801
Total	212	100.0		1,805

The study shows that 4 respondents (1.9%) have 1-100 trees, 4 respondents (1.9%) have 101-300 trees, and 2 respondents (0.9%) have 301-500 trees. The study area has a total of 1,805 trees of Jatropha. Table 4.25 shows the production of Jatropha seeds in the study area.

Table 4.25 Jatropha production in form of seeds

Jatropha production (Kg.)	Frequency	Percentage	Median	Total production (Kg.)
none	207	97.6	0	0
1-100	5	2.4	50.5	252.5
Total	212	100.0		

The findings show that 5 respondents (2.4%) have mature Jatropha trees and produce 1-100 Kilogrammes. The total production of Jatropha seeds is 252.5 Kg.

4.6.2 Jatropha Marketing and income generation

Jatropha is planted for cow's shelter, income generation and soil conservation. When planted as a cow shelter, the plant does not require application of fertilizer or manure. The plants under such use are healthier and produce more seeds per tree in relation to those planted as fence or income generation. Table 4.26 shows the income generated from Jatropha sales.

Table 4.26 Income from Jatropha sales

Income from Jatropha sales (KShs)	Frequency	Percentage	Median	Total income (KShs)
none	207	97.6	0	0
501-1000	2	0.9	750.5	1,501
1001-3000	3	1.4	2000.5	6,001.5
Total	212	100.0		7502.5

The study shows that 2 respondents (0.9%) obtained 501-1000 shillings while 3 respondents (1.4%) obtained 1001-3000 shillings from Jatropha seed sales. The study also indicates that a total of 7,502.5 Kenya shillings were got from Jatropha sales in the study area. Most of the Jatropha trees are in their flowering stage and therefore the production is expected to increase when the trees mature.

4.7 Contribution of Organic Farming on food security among households

In this section, finding on households carrying out organic farming, organic farming and income generation and contribution of organic farming to food security are presented.

4.7.1 Organic Farming

Organic farming improves soil fertility which is key to successful crop production. It also enhances soil structures, conserves water and ensures the conservation and sustainable use of biodiversity. Table 4.27 indicates the number of respondents undertaking organic farming in the study area.

Table 4.27 Households carrying out organic farming

Households practicing organic farming	Frequency	Percentage
Yes	199	93.9
No	13	6.1
Total	212	100.0

The study indicates that 199 respondents (93.9%) undertake organic farming while 13 respondents (6.1%) do not undertake organic farming. Organic farming is more popular because other agricultural technologies like mushroom farming, green house horticultural farming and

Jatropha farming use organic manure to boost their production. Table 4.28 shows the amount of organic manure produced by respondents in the study area.

Table 4.28 Quantity of manure produced

Quantity of manure (Kg)	Median	Household Compost	Total compost	Household Cow	Total manure (cow)	Household (sheep/goat)	Total manure (sheep/goat)	Household (poultry)	Total poultry manure
None	0	183	0	73	0	173	0	137	0
1-500	250.5	22	5511	99	24,799.5	33	8266.5	65	16282.5
501-1000	750.5	3	2251.5	23	17261.5	3	2251.5	4	3002
1001-2000	1500.5	2	3001	5	7502.5	1	1500.5	3	4501.5
over 2000	2000	2	4000	12	24000	2	4000	3	6000
Total		212	14,763.5	212	73,563.5	212	16,018.5	212	29,786

The study indicates that 22 households produced 1-500Kg of compost,3 households produced 501-1000Kg of compost,2 households produced 1001-2000Kg of compost and 2 households produced over 2000Kg of compost; 99 households produced 1-500Kg of cow manure,23 households produced 501-1000Kg of cow manure,5 households produced 1001-2000Kg of cow manure and 12 households produced over 2000Kg of cow manure; 33 households produced 1-500Kg of sheep/goats manure,3 households produced 501-1000Kg of sheep/goat manure,1 households produced 1001-2000Kg of sheep/goat manure and 2 households produced over 2000Kg of sheep/goat manure; 65 households produced 1-500Kg of poultry manure,4 households produced 501-1000Kg of poultry manure,3 households produced 1001-2000Kg of poultry manure and 3 households produced over 2000kgs of poultry manure. The study also indicates that the total production was as follows; 14,763.5Kg from compost manure, 73,563.5Kg from cow manure, 16, 018.5Kg from sheep/goats manure and 29,786 Kg from poultry manure. This shows that most respondents produced cow manure (73,563.5Kg) which is 68.5% of the total. The study shows that 199 households (93.9%) undertake organic farming while 13 respondents (6.1%) do not undertake organic farming. The study further indicates that 29 respondents had compost manure, 139 respondents had cow manure, 39 had sheep/goat manure and 75 respondents had poultry manure.

4.7.2 Organic farming and income generation

Some households sold organic manure to neighbors and other farmers to generate revenue which they can use to purchase food stuffs. Table 4.29 shows the revenue generated from organic manure sales.

Table 4.29 Income generated from organic manure sales

Revenue(KShs)	Frequency	Percentage	Median	Total Revenue (KShs)
None	202	95.3	0	0
1-1000	5	2.4	500.5	25002.5
1001-5000	3	1.4	3000.5	9000.5
Over 20000	2	0.9	20,000	40,000
Total	212	100.0		74,003

The study shows that 5 respondents (2.4%) got 1-1000 Kenyan shillings from Manure sales, 3 respondents (1.4%) got 1001-5000 Kenyan shillings from Manure sales and 2 respondents (0.9%) got over 20,000 Kenyan shillings from Manure sales. The study also indicates that all organic manures generated 74,003 Kenya shillings besides improving soil fertility and yields productivity.

4.7.3 Contribution of organic farming to food security

Respondents were asked to list how organic farming contributes to food security. Table 4.30 shows the Contribution of organic manure to food security.

Table 4.30 Contribution of organic manure to food security

Contribution of organic manure	Frequency	Percentage
None	13	6.1
Soil fertility	67	31.6
Improved crop production	110	51.9
Improved farm incomes	22	10.4
Total	212	100.0

The study shows that 67 respondents (31.6%) stated that organic manure help them improve soil fertility,110 respondents (51.9%) said that it improves their crop productivity,22 respondents(10.4%) said that it improves their income directly through its sales and indirectly through improved crop production.

4.8 Contribution of agricultural technologies on food security among households

This section shows the ranking of agricultural technologies in terms of their importance among the households, amount of farm produce produced, household income generated from farm produce sales and income generated from agricultural technologies.

4.8.1 Ranking of agricultural technologies among households

The respondents were asked to rank the agricultural technologies provided in order of which of them is most important, important, less important and least important. Table 4.31 shows the ranking of agricultural technologies.

Table 4.31 Ranking of agricultural technologies

	Mushroom production		Green house horticultural production		Organic farming		Jatropha Production	
Rank	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Most important	20	9.4	40	18.9	150	70.8	7	3.3
Important	44	20.8	112	52.8	40	18.9	18	8.5
Less important	107	50.5	52	24.5	14	6.6	33	15.6
Least important	41	19.3	8	3.8	8	3.8	154	72.6
Total	212	100	212	100	212	100	212	100

The study indicates that organic farming was the most important technology as indicated by 150 respondents (70.8%), green house horticultural production was important as indicated by 112 respondents (52.8%) ,mushroom is less important as indicated by 107 respondents (50.5%) and Jatropha production is least important as indicated by 154 respondents (72.6%). Organic farming was the most popular technology practised in the study area.

4.8.1 Amount of farm produce harvested

The study focused at the production of maize, beans and potatoes since they are major contributors of food security in the study area. Table 4.32 shows the production of maize.

Table 4.32 Amount of Maize produced

Amount of maize produced (Kg)	Frequency	Percentage	Median	Total production (Kg)
None	6	2.8	0	0
1-200	151	71.2	100.5	15,175.5
201-400	30	14.2	300.5	9015
401-600	8	3.8	500.5	4004
601-800	1	0.5	700.5	700.5
over 800	16	7.5	800	12,800
Total	212	100.0		41,695

The study shows 206 respondents (97.2%) produced maize. The study further shows that 151 respondents (71.2%) produce maize in the range of 1-200 Kg and the total amount of maize produced was 41,695 Kilogrammes.

Table 4.33 shows the amount of beans produced.

Table 4.33 Amount of beans produced

Amount of beans (Kg)	Frequency	Percentage	Median	Total production (Kg)
none	48	22.6	0	0
1-200	157	74.1	100.5	15778.5
201-400	2	0.9	300.5	601
over 800	5	2.4	800	4,000
Total	212	100.0		20,379.5

The study indicates that 157 respondents produced 15778.5,2 Kgs of beans, 2 respondents (0.9%) produced 601 Kilogrammes of beans and 5 respondents produced 4,000 Kilogrammes of beans. A total of 20,379.5 Kilogrammes of beans was produced by the respondents. Table 4.34 shows the production of Irish potatoes by the respondents.

Table 4.34 Amount of Irish Potatoes produced

Amount of potatoes (Kg)	Frequency	Percentage	Median	Total production (Kg)
none	138	65.1	0	0
1-200	69	32.5	100.5	6934.5
201-400	2	0.9	300.5	601
over 800	3	1.4	800	2400
Total	212	100.0		9935.5

The findings indicate that 138 respondents (65.1%) do not produce Irish potatoes while 69 respondents (32.5%) produced 6934.5 Kilogrammes. The study further shows 9,935.5 Kilogrammes of Irish potatoes were produced in total.

4.8.2 Household income generation from crop sales

This section shows the value of the food stuffs (maize, beans and potatoes) produced by the respondents. Table 4.35 shows the value of produced maize.

Table 4.35 Value of maize produced

Value of maize (KShs)	Frequency	Percentage	Median (KShs)	Total value (KShs)
None	7	3.3	0	0
2500	49	23.1	2500	22500
2501-5,000	35	16.5	2600.5	91017.5
5001-10,000	55	25.9	7500.5	412527.5
10,001-20,000	27	12.7	15000.5	405013.5
Over 20,000	39	18.4	20,000	780,000
Total	212	100.0		1,711,058.5

The study shows that the amount of maize produced had a value of 1,711,058 Kenya shillings. Table 4.36 shows the value of produced beans.

Table 4.36 Value of beans produced

Value of beans produced (KShs)	Frequency	Percentage	Median (KShs)	Total value (KShs)
None	51	24.1	0	0
4,000	104	49.1	4,000	416,000
4001-8,000	32	15.1	6000.5	192,016
8,001-16,000	8	3.8	12000.5	96,004
16,001-24,000	10	4.7	20,000.5	200,005
Over 24,000	7	3.3	24,000	168,000
Total	212	100.0		1,072,025

The study shows that the 104 respondents (49.1%) got about 4,000 Kenya shillings each from beans produced. The total beans sold were worth 1,072,025 Kenya shillings. Table 4.37 shows the value of Irish potatoes produced.

Table 4.37 shows the value of Irish potatoes produced.

Value of potatoes (KShs)	Frequency	Percentage	Median	Total value (KShs)
None	138	65.1	0	0
2000	51	24.1	2000	102,000
2001-3000	8	3.8	2500.5	20,004
3001-4000	5	2.4	3500.5	17,502.5
over5000	10	4.7	5000	50,000
Total	212	100.0		189,507

The study shows that the value of Irish potatoes produced was 189,507 Kenya shillings.

4.8.3 Income generated from the agricultural technologies

The income generated from the agricultural technologies was got from the analysed table 4.11 for mushroom production, Table 4.17 for green house horticultural production, Table 4.23 for Jatropha production and Table 4.26 for organic farming. The total income generated from the agricultural technologies is shown in Table 4.38.

Table 4.38 Income from the agricultural technologies

Technology	Number of respondents practising the technology	Value of produce sold (KShs)
Mushroom	12	235,006
Green house horticultural production	21	3,650,007
Jatropha production	10	7502.5
Organic farming	199	74,003
Total		3,966,518.5

The study shows that mushroom production generated 235,006 Kenyan shillings, Green house horticultural production generated 3,650,007 Kenyan shillings, Jatropha production generated 7502.5 Kenyan shillings and organic farming generated 74,003 Kenyan shillings. In total all the four agricultural technologies generated 3,966,518.5 Kenyan shillings.

4.9 Summary of Chapter

The data collected was analysed using Statistical Package for Social Sciences and tables were used to present data in APA table format. The response rate was 100% and majority of 212 respondents interviewed had ordinary level of education as their highest level. The data interpretation focused on mushroom production, green house horticultural production, Jatropha production, organic farming and contribution of agricultural technologies on food security among households. Mushroom production aspects analysed included; households growing mushroom, mushroom production, mushroom consumption, mushroom markets, and farmers empowerment through farm inputs. Green house horticultural production aspects analysed included; households practising green house horticultural production, horticultural crops grown, green house horticultural production, green house horticultural crops marketing, green house horticultural crops income generation and green house farm input providers. Jatropha production aspects analysed included; households practising Jatropha production, Number of Jatropha trees grown, Jatropha production and Jatropha marketing and income generation. Organic farming aspects analysed include; households practising organic farming, quantities of manure produced, organic farming and income generation. Contribution of agricultural technologies on food security aspects analysed included ranking of agricultural technologies, amount of crops (maize, beans and Irish potatoes) produced, income/value generated from crop sales and finally income generated from recent agricultural technologies. The study shows that mushroom production generated 235,006 Kenyan shillings, Green house horticultural production generated 3,650,007 Kenyan shillings, Jatropha production generated 7502.5 Kenyan shillings and organic farming generated 74,003 Kenyan shillings in addition to improving soil fertility and hence improved crop production. It was found that all the four agricultural technologies generated 3,966,518.5 Kenyan shillings. Besides income from agricultural technologies, respondents obtained 1,711,058.5 Kenyan shillings from maize production, 1,072,025 Kenyan shillings from bean production and 189,509 Kenyan shillings from Irish potato production.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on the summary of findings of the study which formed the foundation for discussions. The discussions provided a firm basis upon which conclusions and recommendations were advanced to address agricultural technologies influencing food security among households in Barut and Lanet Divisions. It also includes suggested areas for further research and contributions made to the body of knowledge.

5.2 Summary of Findings

The summary of findings is presented based on the five objectives of the study.

The summary of the findings based on objective one which was to assess mushroom production and food security among households in Barut and Lanet Divisions. The findings show that 12 households (5.7%) are practising mushroom farming. The study indicated that most small scale households do not practise mushroom production because they do not know about it (39.6%),some lack technical knowledge(17.6%),some lack capital(26.4%),some have small land sizes(6.6%) and others felt there is no market for mushrooms(5.7%).The findings also indicated that in 2010, 8 respondents (3.8%) produced 1-200kgs of mushroom; in 2011, 4 respondents (4%) produced 1-200kgs and in 2012, 7 respondents (3.3%) produced 1-200kgs.The findings further indicated that the production of mushroom over the three years is low despite the great demand both locally and internationally. The findings indicated that 12 respondents (5.7 %) consume mushroom in the range of 1-200kgs per year. That is consumption at the local or household level is low.

The study further showed that 11 respondents (5.2%) sell 1-200kgs and 1 respondent (0.5%) sell 601-800kgs of mushroom products. According to the findings 4 respondents (1.9%) got 1-5,000 Kenyan shillings from mushroom sales,6 respondents(2.8%) got 10,001-20,000 Kenyan shillings,1 respondent(0.5%) got 30,001-40,000 Kenyan shillings and 1 respondent(0.5%) got over 40,000 Kenyan shillings from mushroom sales. The study indicated that from 12 households practising mushroom, 235,006 Kenyan shillings was generated from sales.

Only 1 respondent (0.5%) got financial support of 100001-150,000 shillings from Njaa Marufuku Kenya to expand mushroom production.

The summary of findings based on objective two which was to determine green house horticultural production and food security among households in Lanet and Barut Divisions, Nakuru District. The study observed that 21 respondents (9.9%) are practising green house horticultural farming. The study also found that lack of capital affected 82 respondents (38.7%) and was the major challenge in green house horticultural production. Tomato was the main green house horticultural crop grown. The study further showed that out of 21 (9.9%) households practising green house, 11(5.2%) grow tomatoes alone. The remaining households grow tomatoes combined with something else like capsicum, cucumber, spinach, onions and vegetables.

The study showed that 9 out of 21 households (4.2%) produced 1001-4000kgs of horticultural products .Only one household produced 8001-10,000kgs which was recorded as the highest. The study has shown that the 21 respondents produced 76,509 kilogrammes on average. The study indicated that majority sold their horticultural products to supermarkets, that is 12(5.7%) out of 21(9.9%).Other respondents sold at farm gate, hotels and open air markets. The study has also shown that the respondents sell their green house products locally and this has made 1.9% of respondents not to take up green house technology because of uncertainty of market. The research findings have shown that 5 respondents (2.4%) obtained income of 1-10,000shillings, 3 respondents (1.4%) obtained income of 5,001-100,000shillings, 2 respondents (0.9%) obtained income of 100,001-200,000shillings, 4 respondents (0.9%) obtained income of 200,001-300,000shillings but majority of the respondents (7) obtained an income of over 300,000 Kenya shillings. The findings further indicated that a total of 3,650,007 Kenya shillings were obtained from total sales of green house products from the study area.

The findings have shown that 1 respondent (0.5%) was supported by ministry of Agriculture with farm inputs worth 100,001-200,000 shillings, 2 respondents (0.9%) by constituency development fund with farm inputs worth 200,001-300,000 shillings and 1 respondent (0.5%) by child mother fund with farm inputs worth 50,001-100,000 shillings.

The summary of findings based on objective three which was to assess Jatropha production and food security among households in Lanet and Barut Divisions of Nakuru District. The findings showed that only 10 respondents were growing Jatropha in the study area .The findings also indicated that 131 respondents (61.8%) do not know how to grow Jatropha, 25 respondents (11.8%) respondents lacked adequate land, 27 respondents (12.7%) had no capital and 14 respondents (6.6%) lacked planting material while 5 respondents (2.4%) did not know where to

market Jatropha. The findings also showed that 4 respondents (1.9%) have 1-100trees, 4 respondents (1.9%) have 101-300trees, and 2 respondents (0.9%) have 301-500trees. The study area had an estimated 1,805 trees of Jatropha. Five respondents (2.4%) had mature Jatropha trees which were in production. The estimated total production was 252.5 kgs of Jatropha seeds which generated 7502.5 Kenyan shillings from sales. There was no support in form of inputs was provided by service providers.

The summary of findings based on objective four which was to assess organic farming and food security among households in Lanet and Barut Divisions of Nakuru District. The study indicated that 199 households (93.9%) undertook organic farming while 13 respondents (6.1%) did not undertake organic farming. The study also indicated that 29 respondents had compost manure, 139 respondents had cow manure, 39 had sheep/goat manure and 75 respondents had poultry manure. The study showed that 5 respondents (2.4%) got 1-1000 Kenyan shillings from Manure sales, 3 respondents (1.4%) got 1001-5000 Kenyan shillings from Manure sales and 2 respondents (0.9%) got over 20,000 Kenyan shillings from Manure sales. Sixty seven (67) respondents (31.6%) stated that organic manure helped them to improve soil fertility, 110(51.9%) to improve crop productivity, 22 respondents (10.4%) to improve their income directly through its sales or indirectly through improved crop production. The study also indicated that organic farming was the most important technology as indicated by 150(70.8%) respondents, green house horticultural production was important as indicated by 112(52.8%) respondents ,mushroom is less important as indicated by 107(50.5%) respondents and Jatropha production is least important as indicated by 154 (72.6%) respondents. The study also showed that organic farming was the most important technology as indicated by 150(70.8%) respondents, green house horticultural production was important as indicated by 112(52.8%) respondents ,mushroom is less important as indicated by 107(50.5%) respondents and Jatropha production is least important as indicated by 154(72.6%) respondents. The study showed Mushroom production generated 235,006 Kenyan shillings, Green house horticultural production generated 3,650,007 Kenyan shillings, Jatropha production generated 7502.5 Kenyan shillings and organic farming generated 74,003 Kenyan shillings. In total all the four agricultural technologies generated 3,966,518.5 Kenyan shillings.

5.3 Discussion of Findings

A discussion of findings of the study is presented based on the four objectives of the study.

5.3.1 Contribution of Mushroom production and food security

Mushroom production contributes to food security among households in Barut and Lanet Divisions. The findings indicated that the production of mushroom is low despite the great demand both locally and internationally. The findings show that only 12 farmers (5.7%) are practising mushroom farming while 200(94.3%) households are not practising mushroom production. The findings indicated that the production of mushroom is low despite the great demand both locally and internationally. The findings agree with Ministry of Agriculture report (2011), which indicated that the bulk of Kenya mushroom production which stands at 500 tonnes per annum come from large scale farms which constitutes 90-95% of the total production while small scale farms constitute 5-10%. According to Ministry of Agriculture (2012), Kenya produces 500 tonnes per annum against an annual demand of 1200 tons both in hotels and home consumption. It imports 80,000 tonnes to satisfy its tourist industry. This indicates that there is a great potential of mushroom production since there is great demand both locally and internationally. However, mushroom production is still low in Kenya. According to this study 8 (3.8%). respondents do not practise mushroom farming because felt there is no market. This agrees with Inter American Development Bank (2013), who indicated in their study that in order to maintain or increase agricultural growth and to face the challenges of feeding an increasing population and adapting to the impacts of climate change, there is a need to help farmers increase their productivity with greater access to markets.

The findings also indicated that 12 respondents (5.7 %) consume mushroom in the range of 1-200kgs per year. That is, consumption at the local or household level is low despite the fact that Mushroom production in Barut and Lanet Divisions has been increasing. This agrees with findings by Mayett et al., (2004) who stated that the future of mushroom cultivation will also depend on a thorough understanding of consumption trends worldwide, especially in developing countries where mushroom production is in its infancy stage.

The research shows that only 1 respondent (0.5%) got financial support in form of finances of 100001-150,000 shillings. Smallholder agriculture play an important role in reducing the vulnerability of rural and urban food insecure households, improving livelihoods and helping to mitigate high food price inflation. It is therefore important that service providers support small scale farmers with form farm inputs. This is supported by Baiphethi and Jacobs (2009), who

stated that there is a need to significantly increase the productivity of subsistence/smallholder agriculture and ensure long-term food security. This will enable vulnerable small scale farmers to produce mushroom products. There is a need to determine methods of identifying cost-effective ways to improve access to inputs, improving delivery and assisting farmers to earn cash to purchase inputs thereby improving food security.

The study showed that from 12 households practising mushroom, 235,006 Kenyan shillings was generated from sales. For a household of six persons to be food sufficient it required six bags of maize and two bags of beans or 23,000 Kenya shillings (Figure 1).The 235,006 Kenya shillings generated through mushroom production can feed about 10 households. This is supported by UNDP report (2012) which indicated that a small field which usually produces a few vegetables every month, can provide a household with enough mushrooms for food and revenues weekly for instance in $1m^2$ a family can harvest 75 Kg of mushrooms every 1 or 2 weeks. This also collaborates study by Gateri (2012) who stated that Mushroom cultivation can directly improve livelihoods through income generation, food security and better health. The study therefore shows that there are several opportunities along the mushroom value chain that can be exploited thereby generating income, providing food security and creating employment for several people. There is a need to promote mushroom production and consumption especially in the rural areas where food insecurity is prevalent. Therefore mushroom production influence food security in the study area.

5.3.2 Contribution of Green house horticultural production on food security

Green house horticultural production contributes to food security among households in Lanet and Barut Divisions. Majority of farmers in the study area are small scale farmers with 0.6-1 acre of land as shown in Table 4.6 who undertake green house horticultural crops production for household consumption and for income generation. Faced with reduced acreage for farming due to population growth and unpredictable weather conditions, farmers in the study area are turning to greenhouse farming technology as a way to increase food production and supplement their income. USAID (2012) also report indicated that 98 percent of the crop grown under Green house production is marketable, compared to only 15 percent of the crop grown in open fields due to damage from hailstorms and disease infection. The study indicated that 21 respondents are undertaking green house horticultural production. These are mainly small scale farmers with 0.6-1 acre of land who are sometimes faced with food insecurity because of their small pieces of land. This agrees with USAID (2012) who indicated that Smallholder production is based on

low-input and traditional farming practices coupled with rapid population growth which impact negatively on sufficient food production. The study observed that 21 respondents (9.9%) are practising green house horticultural farming while 191 households are not practising green house horticultural production. The study further showed that out of 21 (9.9%) households practising green house, 11 (5.2%) grow tomatoes alone. Tomato was the main green house horticultural crop grown in the study area. This agrees with Ministry of Agriculture report (2011), which indicated that green houses in Lanet and Barut Divisions are mainly for tomato production. The report further stated that it takes two months for greenhouse produced tomatoes to mature, while it takes a minimum of three months with outdoor farming. Farmers in the study area prefer to grow tomatoes because it is a high-yield plant and one that gets returns in three months after planting. This further agrees with USAID report (2012) which indicated that with introduction of green house technology, the losses due to hailstones, pests and diseases incidences is reduced by more than 90%.

The study found that lack of capital affected 82 respondents (38.7%) and was the major challenge in green house horticultural production. This agrees with USAID report (2012) which stated that adoption of horticultural technologies in Kenya is partial because of non affordability of the technology, lack of technology awareness and technical knowhow, availability of the technologies and accompanying support services.

The findings showed that one respondent (0.5%) was supported by ministry of Agriculture with farm inputs worth 100,001-200,000 shillings, two respondents (0.9%) by constituency development fund with farm inputs worth 200,001-300,000 shillings and one respondent (0.5%) by child mother fund with farm inputs worth 50,001-100,000 shillings. These supported households were vulnerable but the support by ministry of Agriculture, Constituency Development Fund and child mother fund made them to practise green house horticultural production. The findings are supported by Wasilwa (2008) who stated that high cost of inputs has hindered most farmers from keeping pace with changing technological advances. USAID (2012) also stated that the adoption of technologies is dependent on demonstration and training on user friendly advanced technologies.

The study indicated that majority of respondents 12(5.7%) out of 21 respondents (9.9%) sold their horticultural products to supermarkets. The other respondents sold their produce at farm gate, hotels and open air markets. The findings further indicated that a total of 3,650,007 Kenya shillings was obtained from total sales of green house horticultural products. For a household of

six persons to be food sufficient it required six bags of maize and two bags of beans or 23,000 Kenya shillings (Figure 1).The 3,650,007 Kenya shillings generated through green house farming can feed about 158 households. This agrees with Engelman (2011) who advised that with global population at 7 billion, we need a swift transformation of energy, water, and materials consumption through conservation, efficiency, and green technologies. Green house farming has fewer requirements for chemicals, manure and the crops are shielded from direct rainfall and sunlight. Insects that affect the vegetable crops are also minimized when tunnel greenhouse is used. Green house horticultural crops are high value crops generating higher profits than staple food crops per unit of land and the income thus generated can be used for different purposes in terms of eradicating hunger through meeting the food requirements and other necessities. This further agrees with Burney et al. (2010), who said that households becoming strong net producers in vegetables, with extra income earned from sales significantly increasing their purchases of cereals, pulses and protein and oils during rainy season.

Besides providing food and income green house horticultural production ensured production throughout the year and also is a source of employment for people in the study area. This agrees with Government of Kenya report (2011) which indicated that the horticultural subsector employs approximately 4.5 million people countrywide directly in production, processing, and marketing, while another 3.5 million people benefit indirectly through trade and other activities. Therefore green house horticultural production influence food security in the study area.

5.3.3 Jatropha production in food security alleviation among households

The findings showed that only 10 respondents were growing Jatropha in the study area while 202 were not practising Jatropha production. The reasons of not growing Jatropha according to the study were 131 respondents (61.8%) respondents did not know how to grow Jatropha, 25 respondents (11.8%) respondents lacked adequate land, 27 respondents (12.7%) had no capital, and 14 respondents (6.6%) lacked planting material while 5 respondents (2.4%) did not know where to market Jatropha. Though Jatropha is viewed as a potential biodiesel feedstock, its adoption occupies a sizeable piece of land which would otherwise be used for food production. This has made 11.8% of respondents indicated that they do not have adequate piece of land. This agrees with Moraa et al. (2009) who indicated that wide adoption of Jatropha into farmers' fields will replace existing food crops and thus perceived as a potential threat to food security. This further agrees with Mitchell (2008), stated that the decisions that rural households make in allocating key resources such as land and labour, can determine if and how they adopt jatropha

and the implications for local food security and socio-economic development. In the study area, Jatropha production is promoted by panda pata which is a non governmental organization. This collaborates study by Tomomatsu and Swallow (2007) production of Jatropha curcas has been widely promoted by private enterprises, nongovernmental organizations and development agencies as one of the most viable candidates for biodiesel feedstock in Africa. . In the study area, 1,805 Jatropha trees were planted as shown in Table 4.21 with production of 252.5 kilogrammes in form of seeds. This production is low because out of ten respondents with jatropha trees only five respondents (5) have mature Jatropha trees. From Figure 1, a household of six persons require six bags of maize and two bags of beans or 23,000 Kenya shillings to be food sufficient. Therefore 7502.5 Kenyan shillings from Jatropha sales cannot be able to feed even one household per year. Therefore even at full maturity, production is likely to be still plow. This collaborates study by Ehrensperger et al. (2006) who said that activities which increase pressure on land for example biofuel production have to be promoted with great care and after careful assessment of local conditions in the targeted contexts. He further stated that in the case of Jatropha, hedge production should be favoured over plot based production. The Jatropha plants under hedge are more cost effective and also influence food security.

5.3.4 Contribution of organic farming in food security among households

The study showed that 199 households (93.9%) undertook organic farming while 13 respondents (6.1%) did not undertake organic farming. It further indicated that organic farming was very important to respondents' food security. This agrees with Grandi (2012) who indicated that organic farming is well recognized for its contribution to improving food security and alleviating poverty, proactively creating new local and export markets, and driving sustainable rural development through the empowerment of farmers and their organizations. This also collaborates study by Smallwood (2012), who said that we can double food production in just 10 years using organic practices and other agro ecological farming methods. He further stated that Organic farming creates more of the resources on which our food supply relies, while conventional farming destroys them.

The study indicated that 29 respondents had compost manure, 139 respondents had cow manure, 39 had sheep/goat manure and 75 respondents had poultry manure. The study showed that cow manure was used by majority of the respondents. This collaborates with study by Lekasi et al. (2001) who stated that Livestock ownership is widespread amongst households in the high potential areas with between 77 and 85% of households keeping dairy cattle. This is because

apart from cow producing a lot of milk, it produces manure which can be used for biogas production and also as manure for farm fertility improvement. Sixty seven (67) respondents (31.6%) stated that organic manure helped them to improve soil fertility, 110 respondents (51.9%) to improve crop productivity, 22 respondents (10.4%) to improve their income directly through its sales or indirectly through improved crop production. This agrees with Prabu (2010) who said that the quality of the agricultural products, such as flowers, vegetables and fruits, improves when organic manures are supplied rather than fertilizers. Animal manures contribute more to the soil than just nitrogen, phosphorus, and potassium. Continued use of manures builds organic matter in soils and improves soil structure. This modification of soil structure helps improve water holding capacity, aeration, friability, and drainage. In addition, many trace nutrients needed for optimum plant growth are available from manures. Plant nutrients are also released more slowly and over a longer period of time than from most commercial fertilizers. The study showed that all organic manures generated 74,003 Kenya shillings besides improving soil fertility and yields productivity. This amount can be able to feed three (3) Households per year in addition to 199 households who improved their soil fertility and hence increased farm incomes.

Organic farming was ranked as the most important recent agricultural technology in the study area. This is because agricultural technologies like mushroom farming, green house horticultural farming and Jatropha farming use organic manure to boost their production. This is also because inorganic fertilizers are very expensive while organic manure is produced locally. This is supported by findings of Wambua (2012) who stated that organic farming increases soil fertility, controls pests and diseases, saves our environment from chemical deposits, makes our ground water clean and safe, and saves the farmer on money that would have been used on expensive farm inputs such as fertilizer. He also indicated that organic farming produces safe and nutritious foods that fetch better prices in the market. Organic manure improves the livelihoods of small-scale farmers involved in organic farming. Organic food products are in high demand and there already exist organic farmers' markets. The foods sell at good prices and farmers can increase their incomes by simply taking on organic farming. This also agrees with Prabu (2010) who said that continued use of manures builds organic matter in soils and improves soil structure. This modification of soil structure helps improve water holding capacity, aeration, friability, and drainage. In addition, many trace nutrients needed for optimum plant growth are available from manures. Plant nutrients are also released more slowly and over a longer period of time than

from most commercial fertilizers. Therefore organic farming influence food security of the study area.

5.3.5 Contribution of agricultural technologies to food security

Barret (2002) indicated that food security is linked to the consumption, production, and marketing of food, the functioning of factor markets especially for labor social safety nets, governmental and nongovernmental assistance agencies, initial asset and income distributions, and myriad other subjects across several disciplines. This research indicated that mushroom farming, green house horticultural farming, Jatropha farming and organic farming contributed to food security in the study area. This agrees with Valero (2010), who indicated that adoption of technology by farmers' increases food production and food security thereby contributing to national goal of improved livelihoods of Kenyans.

Mushroom production generated 235,006 Kenyan shillings from sales. The 235,006 Kenya shillings generated through mushroom production can feed about 10 households (refer to Figure 2). This collaborates study by Gateri (2012) who stated that Mushroom cultivation can directly improve livelihoods through income generation, food security and better health.

Organic farming was the most popular technology as indicated by 150(70.8%) respondents. This is collaborated by Grandi (2012) who reported that, organic farming is well recognized for its contribution to improving food security and alleviating poverty, proactively creating new local and export markets, and driving sustainable rural development through the empowerment of farmers and their organizations.

Green house horticultural production generated most income of 3,650,007 Kenyan shillings which was 92 % of the total income generated 3,966,518.5 Kenyan shillings from all technologies (mushroom, green house, organic farming and Jatropha production). This agrees with the study by Kagwa (2012) who indicated that faced with reduced acreage for farming due to population growth and unpredictable weather conditions, many Kenyans are turning to greenhouse farming technology as a way to increase food production and supplement their income. Many Kenyans are adopting greenhouse farming because it requires very little capital to set up compared to benefits and farmers are able to produce more on a small farm.

The total production of Jatropha was 252.5 kgs of seeds which generated 7502.5 Kenyan shillings from sales. The 7502.5 Kenyan shillings generated from Jatropha sales cannot be able to feed even one household per year, since one household of six persons require 23,000 Kenyan shillings. This is because out of ten (10) Jatropha households only five (5) have mature Jatropha

trees. However, this production is low. This collaborates study by Ehrensperger et al.2006) who said that activities which increase pressure on land for example biofuel production, have to be promoted with great care and after careful assessment of local conditions in the targeted contexts. He further stated that in the case of Jatropha, hedge production should be favoured over plot based production.

5.4 Conclusions of the study

The followings conclusions were made from the study:

It is concluded that mushroom production contributes to food security in Barut and Lanet Divisions of Nakuru District. The findings clearly indicated that there is a great potential of mushroom production since there is great demand both locally and internationally since Kenya produces 500 tons per annum of mushroom against an annual demand of 1200 tons both in hotels and home consumption. Some small scale farmers do not practise mushroom because they do not know it, they lack technical knowhow, lack capital, have small land sizes while others are not sure of markets. The consumption of mushroom at the local or household level is low and therefore thorough understanding of consumption trends worldwide is important. Mushroom production improves food security and generates income which improves livelihoods of households. Further the study has shown that there are several opportunities along the mushroom value chain which when exploited generate income, provide food security and create employment for several people. It is also clear that there is a need to promote mushroom production and consumption especially in the rural areas where food insecurity is prevalent.

It can also be concluded that green house horticultural production contributes to food security among households in Lanet and Barut Divisions. Lack of capital is a major challenge in green house horticultural production. Vulnerable households are able to undertake green house horticultural production when they are supported with farm inputs. The adoption of recent agricultural technologies is dependent on demonstration and training on user friendly advanced technologies. Production of green house tomato is taking prominence in the study area because when planted in the open fields, farmers incur heavy losses because hailstones and pests and disease incidences. Farmers in the study area prefer growing tomatoes because it is a high-yield plant and one that gets returns in two months after planting. Majority of Households sell their horticultural products to supermarkets, others sell at farm gate, hotels and open air markets. Green house farming has fewer requirements for chemicals, manure and the crops are shielded from direct rainfall and sunlight. Insects that affect the vegetable crops are also minimized when

green house is used.

It is concluded that Jatropha production contributes to food security among households in the study area. Unlike other recent agricultural technologies, Jatropha production is land intensive. From ten (10) households practicing Jatropha production only five households have mature Jatropha trees. Jatropha production for hedge is more favoured over plot based production.

It is also concluded that organic farming contributes to food security among households in Barut and Lanet Divisions. Cow manure is produced and used by majority of the households. Organic manure help households to improve soil fertility, crop productivity, household income and crop production. Mushroom farming, green house horticultural farming, Jatropha farming and organic farming contribute to food security in the study area. Adoption of technology by farmers' increases food production and food security thereby contributing to national goal of improved livelihoods of Kenyans.

5.5 Recommendations

The following policy recommendations were made from the findings of this study

1. Mushroom production and consumption among households is low despite the fact that there is a great potential of mushroom production in Kenya. It is therefore imperative to promote mushroom production and consumption especially in the rural areas where food insecurity is prevalent.
2. Some households do not adopt green house technologies because they do not have technical knowhow. Adoption of Green house horticultural production is dependent on demonstration and training on user friendly advanced technologies. There is a need to train and demonstrate green house technologies to households to enhance their adoption for food security.
3. Since lack of capital is a major challenge to adoption of agricultural technologies especially in green house horticultural production, vulnerable households should be supported with farm inputs and other materials for demonstrations.
4. Jatropha production is land intensive. In areas where land is limited like the study area, Jatropha production as a hedge should be promoted over plot based production.
5. Organic manure help households to improve soil fertility, crop productivity, household income and crop production. Use of right quantities of manure should be promoted.

5.6 Suggested areas for further Research

The following areas are suggested for further studies from the results of this study

1. A Study to find out why Mushroom production and consumption is low among households despite the fact that there is a great potential of mushroom production in Kenya.
2. A study to find out factors affecting adoption of agricultural technologies in other areas of the Country need to be carried out.
3. An assessment of the role played by financial institutions on the adoption of agricultural technologies among households should be done.

5.7 Contribution to the body of knowledge

Objective	Contribution to knowledge
To assess how indoor mushroom production influence food security among households in Lanet and Barut Divisions, Nakuru District.	Indoor mushroom production is practiced by 12 respondents (5.2%) in the study area who produced 1909.5Kilogrammes and generated 235,006 Kenya shillings. Therefore indoor mushroom production influences food security through food production, income generation and created employment for several people.
To determine how green house horticultural production influence food security among households in Lanet and Barut Divisions, Nakuru District.	Green house horticultural production is practiced by 21 respondents (9.9%) in the study area who produced 76,509 Kilogrammes worth 3,650,007 Kenya shillings. In the study area, 82 respondents indicated that lack of capital is a major challenge in green house horticultural production. Green house horticultural production involved crops like tomatoes, capsicum, cucumber, spinach, onions and vegetables but 11 respondents (52.3%) out of 21 respondents produced only tomatoes. This is because tomatoes give returns within two months after planting. Therefore green house production influences food security through food production and income generation.
To assess the influence of plot based Jatropha production on food security among households in Lanet and Barut	Plot based Jatropha production is practiced by 10 respondents (4.7%) in the study area who produced 252.5 kilogrammes of seeds

Divisions of Nakuru District.	worth 7502.5 Kenya shillings. Jatropha production is land intensive and therefore growing Jatropha as a hedge is more favoured to plot based. Therefore plot based Jatropha production influenced food security through income generation which can be used to purchase cereals, pulses and other food stuffs
To assess the influence of organic farming on food security among households in Lanet and Barut Divisions of Nakuru District. .	Organic farming is practiced by 199 respondents (93.9%) in the study area who generated manure worth 74,003 Kenya shillings from sales besides improving soil fertility and crop productivity. Cow manure is produced by 139 respondents (65.6%) and it is the most preferred manure in the study area. Organic farming boosts production of the other agricultural technologies. The study further showed that organic farming was ranked as the most important among other technologies by 150 respondents(70.8%),green house horticultural farming was ranked as important by 112 respondents(52.8%),mushroom farming was ranked as less important 107 respondents(50.7%) and Jatropha farming was ranked as least important by most respondents 154(72.6%).

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APPENDICES

APPENDIX 1. LETTER REQUESTING FOR TRANSMITTAL TO PROVINCIAL ADMINISTRATION

The District Commissioner

P.O. Box 81

Nakuru.

Dear Sir,

RE: PERMISSION TO CARRY OUT ACADEMIC RESEARCH

I am a graduate student undertaking Masters of Arts Degree in Project Planning and Management in the University of Nairobi and I am conducting a research study entitled "the influence of agricultural technologies on food security among households in Lanet and Barut Divisions.

The purpose of this letter is to request for permission to interview farmers using the attached questionnaire copies. The information obtained is strictly for academic purpose and shall be treated with utmost confidentiality.

Thank You

Yours Faithfully

Kingori .J. Kanjeru

L50/73914/2012

APPENDIX 2. LETTER REQUESTING FOR TRANSMITTAL TO THE RESPONDENTS

P.O. BOX 1544-20100

Nakuru

Dear Sir/Madam,

I am a graduate student undertaking Masters of Arts Degree in Project Planning and Management at the University of Nairobi. I am conducting a research study entitled "the influence of agricultural technologies on food security among households in Lanet and Barut Divisions. You have been selected to assist in providing the required information because your views are considered important to this study.

I am therefore kindly requesting you to fill this questionnaire. Please note that any information given will be treated with utmost confidentiality and will only be used for the purpose of this study.

Thank You.

Yours faithfully

Kingori .J. Kanjeru

L50/73914/2012

APPENDIX 3. RESEARCH QUESTIONNAIRE FOR HOUSEHOLDS

Instructions

The purpose of this questionnaire is to obtain information on agricultural technologies and their contribution on food security.

Please fill the relevant boxes and blank spaces.

Section one: Demographic Data

1. Kindly indicate your gender
   - Male ( )
   - Female ( )
2. Please indicate your age from the choices?
   - 16-25 years ( )
   - 26-35 years ( )
   - 36-45 years ( )
   - 46-55 years ( )
   - Over 55 Years ( )
3. What is your level of education?
   - Never went to school ( )
   - Primary level ( )
   - Ordinary Level ( )
   - Advanced Level ( )
   - Degree Level ( )
   - Masters Level ( )
4. Kindly indicate you Marital status
   - Single ( )
   - Married ( )
   - Others (specify) ( )
5. Please indicate your Household/family size ( )

Section Two: Mushroom production as an agricultural technology

6. (a)Have you been practising mushroom production?

Yes ( )

No ( )

(b) If the answer is No, please state two reasons

i……

ii……

……

(c) If the answer is yes,

(i) Please indicate the types of mushroom you have been growing for the last three years and quantities produced

Type of mushroom	**Quantity produced in Kilograms**		
	2010	**2011**	**2012**

ii. In the following table, please indicate where you have been marketing your mushroom, quantity sold and the amount of income obtained

Type of mushroom	**Year when production took place**	**Type of market**	**Quantity consumed in the household (Kgs)**	**Quantity sold(Kgs)**	**Amount of income obtained**

7. (a) Please list the service providers who have ever supported you with farm inputs in the last three years

……

……

……

……

(b) Please fill the following table concerning farmers' empowerment in form of farm inputs

Type of farm input provided	**Quantity Provided**	**Unit of measure**	**Value of farm input (Ksh)**	**The year when farm input was provided**	**Indicate the service provider**

(c). Please explain how farmers support in form of farm inputs has affected food security

……

……

……

Section Three: Green house horticultural production as an agricultural technology

8. (a)Have you been practising green house horticultural production?

Yes ( )

No ( )

(b) If the answer is No, please state two reasons

i……

ii……

(c) If the answer is yes,

(d) Please indicate the types of green house horticultural crops you have been growing for the last three years and quantities produced

Type of horticultural crop	**Quantity produced in Kilograms**		
	2010	**2011**	**2012**

ii. In the following below, please indicate where you have been marketing your horticultural crops, quantity sold and the amount of income obtained

Type of horticultural crop	**Year when production took place**	**Type of market**	**Quantity consumed in the household (Kgs)**	**Quantity sold(Kgs)**	**Amount of income obtained**

9. (a) Please list the service providers who have supported you with farm inputs for use in agricultural technologies in the last three years

……..

……

……

(b) Please fill the following table concerning farmers' empowerment in form of farm inputs for green house horticultural production

Type of farm input provided	Quantity Provided	Unit of measure	Value of farm input (Ksh)	The year when farm input was provided	Indicate the service provider

Section Three: Jatropha production as an agricultural technology

10. (a) Have you ever grown Jatropha in your farm?

Yes ( )

No ( )

(b) If the answer is No in question 10(a), please list two reasons

i……

……

ii……

……

(c) If the answer is yes in Question 10(a), please fill the following table

Number of Jatropha trees planted	Amount of land used	Quantity produced (Kgs)	Biodiesel produced (Litres)	Revenue generated	How the income was utilized

Section Four: Organic farming

11. (a) Please indicate whether you have been using organic manure in your farm

Yes ( )

No ( )

(b) If yes which type of manure?

From compost heap or pit ( )

From cow ( )

From goats/sheep ( )

From poultry ( )

Others specify ( )

(c) Please indicate the quantities of organic manure produced and used in your farm

Type of manure	**Quantity produced in the farm (Kgs)**	**Quantity bought (if any in Kgs)**	**Quantity used in the farm in Kgs**	**Quantity sold if any in Kgs**	**Revenue generated from sales in Ksh.**

(d) Please state how organic farming can contribute to food security

……

……

……

12. Please fill the following table

Agricultural technologies	**Please tick the technologies you undertake in your farm**	**Rank the technologies you undertake in your farm in order of importance in improving food security in your household using the key below**
Mushroom production		
Green house horticultural production		
Jatropha production		
Use of organic manure		
Others (specify)		

1. Most important 2. Important 3. Less important 4. Least important

Section Five: Contribution of agricultural technologies on food security among households

13. (a) Which of the following crop(s) did you plant last season for your household?

Crop grown	**Amount of crop produce in Kgs**	**Value of crop produce (Ksh)**	**Specify the type of the crop**
Mushroom			
Green house horticulture			
Jatropha			
Maize			
Beans			
Potatoes			

(b) From your farm produce of last season, how much did you consume, store and sell?

Crop grown	**Amount consumed in Kgs**	**Amount stored in Kgs**	**Amount sold in Kgs**
Mushroom			
Green house horticulture			
Jatropha			
Maize			
Beans			
Potatoes			

(c) How do you utilize the income from the farm produce sales? Tick all that apply

Purchase maize and beans ( )

Purchase other crops ( )

Purchase clothing ( )

Pay school fees ( )

Others (specify) ( )

(d) What is the importance of storing food stuffs in your household?

i……

ii……

(e) Maize and beans are important in food security. How do you obtain these food stuffs in your household?

From own farm applied with organic manure ( )

From own farm not applied with organic manure ( )

From income obtained from mushroom, green house horticultural crops ( )

Any other sources (specify) ( )

14. State two ways on how your household income increases food security in your family.

i……

ii……..

15. State two ways on how you utilize income from agricultural technologies (mushroom, green house horticulture, organic farming or Jatropha).

i……

ii…….

16. State two ways on how you deal or mitigate the problem of food insecurity in your household.

i……

…….

ii……

……..

17. Any other comment

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APPENDIX 5. RANDOM SAMPLING OF POPULATIONS USING YAMANE FORMULA (1967)

Sample Size for ±3%, ±5%, ±7%, and ±10% Precision Levels where Confidence Level Is 95% and P=.5.

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
500	A	222	145	83
600	A	240	152	86
700	A	255	158	88
800	A	267	163	89
900	A	277	166	90
1,000	A	286	169	91
2,000	714	333	185	95
3,000	811	353	191	97
4,000	870	364	194	98
5,000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99
15,000	1,034	390	201	99
20,000	1,053	392	204	100
25,000	1,064	394	204	100
50,000	1,087	397	204	100

100,000	1,099	398	204	100
>100,000	1,111	400	204	100
a = Assumption of normal population is poor (Yamane, 1967). The entire population should be sampled.				